REVISED DRAFT REPORT

FEASIBILITY STUDY - ASHLAND/NORTHERN STATES POWER LAKEFRONT SUPERFUND SITE

Prepared for

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Acronyms and Abbreviations

AOC	Administrative Order on Consent
ASTM	Alternatives Screening Technical Memorandum
ARAR	Applicable or Relevant and Appropriate Regulations
bgs	Below ground surface
^oC	Degrees Celsius
CAATM	Comparative Analysis of Alternatives Technical Memorandum
CERCLA	Comprehensive Environmental Response and Compensation Liability Act
COPC	Chemical of Potential Concern
DNAPL	Dense Non-Aqueous Phase Liquid
ES	Enforcement Standard
^oF	Degrees Fahrenheit
FS	Feasibility Study
GRA	General Response Action
LNAPL	Light Non-Aqueous Phase Liquid
MGP	Manufactured Gas Plant
MNA	Monitored natural attenuation
MNR	Monitored natural recovery
MSL	Mean Sea Level
NAPL	Non-Aqueous Phase Liquid
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NOAA	National Oceanographic and Atmospheric Administration
NSPW	Northern States Power Wisconsin
OSWER	Office of Solid Waste and Emergency Response
PAH	Polycyclic Aromatic Hydrocarbon
PRG	Preliminary Remediation Goal
RAO	Remedial Action Objective
RCL	Residual Contaminant Level
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
SOW	Statement of Work
SVOC	Semivolatile Organic Compound
TBC	To Be Considered regulations
UCL	Upper Confidence Limit
URS	URS Corporation
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WAC	Wisconsin Administrative Code
WDNR	Wisconsin Department of Natural Resources
WWTP	Wastewater Treatment Plant

Executive Summary

A Feasibility Study (FS) has been completed to evaluate potential remedial responses for contamination identified at the Ashland NSP Lakefront Superfund Site (the "Site") and results are presented in this report. Contamination was initially discovered in 1989 during exploratory drilling in preparation for a planned expansion of the City wastewater treatment plant (WWTP) located at Kreher Park. Site investigations were subsequently completed culminating in the identification of the former manufactured gas plant (MGP) as the primary source for contamination at the Site. The Wisconsin Department of Natural Resources (WDNR) named Northern States Power Company, a Wisconsin corporation (d.b.a. Xcel Energy, a subsidiary of Xcel Energy Inc. ("NSPW") as a potentially responsible party (PRP) for the MGP wastes/contamination at the site in 1995. The City of Ashland and an operating railroad were later named as PRPs for solid wastes disposed on their properties.

The NSPW and WDNR subsequently performed several independent investigations to assess the extent of contamination on the NSPW property, and at Kreher Park (including adjacent off-shore sediments), respectively. In 1998 a local environmental group petitioned the United States Environmental Protection Agency (USEPA) to evaluate the Site for scoring on the national priorities list (NPL) for Superfund. The site was nominated in 2000, and formally added to the NPL in 2002. NSPW subsequently signed an administrative order on consent (AOC) with USEPA in 2003 to conduct a remedial investigation/feasibility study (RI/FS) at the Site.

The RI/FS Process

The AOC included a Statement of Work that defined eight tasks for this RI/FS. These tasks included:

- Task 1: Project Scoping and RI/FS Planning Documents
- Task 2: Community Relations Support
- Task 3: Site Characterization
- Task 4: Remedial Investigation Report
- Task 5: Development and Screening of Alternatives Technical Memorandum. This task also included development of a Remedial Action Objectives Technical Memorandum.
- Task 6: Treatability Studies
- Task7: Detailed Analysis of Alternatives (FS Report). This task also specified that a Comparative Analysis of Alternatives Technical Memorandum would be submitted to USEPA for approval prior to submission of the FS report.
- Task 8: Progress Reports.

Tasks 1 and 3 involved the scoping and conduct of the Remedial Investigation (RI) which was completed between March and November 2005 to fill data gaps identified from earlier investigations, and to obtain additional data to develop remedial alternatives for the Site. Results from that investigation and previously completed site investigations were presented in the *Remedial Investigation Report for the Ashland/Northern States Power Lakefront Superfund Site* report (Task 4), which was finalized in August 2007. The RI Report was verbally approved by USEPA on October 9, 2007[1] and final written approval issued on February 5, 2008. A summary of RI results is included in section 3.0 of this FS report. A detailed history of the Site can be found in the RI report.

Task 5: Remedial Action Objectives (RAO) Technical Memorandum and Development and Screening of Alternatives Technical Memorandum

Task 5 consisted of two tasks. The RAO Technical Memorandum was submitted as Appendix A to the RI and approved by USEPA on June 6, 2007. The Alternatives Screening Technical Memorandum was initially submitted to USEPA as a draft report on January 22, 2007. Following Agency review and resubmission, this technical memorandum was finalized on September 7, 2007.

The initial step of the alternatives screening process involved the identification of general response actions (GRAs), remedial action technologies and remedial action processes that potentially can be applied to Site media to meet RAOs

General response actions are defined as actions that can be applied to Site media that will result in a RAO being achieved. Potential GRAs for the Site include the following categories:

- No Action;
- Institutional Controls;
- Monitored Natural Recovery
- Containment;
- Removal;
- In-situ Treatment; and
- Ex-situ Treatment.

Several different remedial action technologies could potentially be employed to achieve a RAO. After evaluating each alternative for technical implementability those retained were evaluated in more detail. The evaluation of these alternatives considers implementability, effectiveness and cost and included such information as:

- Time required for the alternative to achieve RAOs;

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[1] As described in the February 5, 2008 RI Report approval letter from USEPA, on September 26, 2007 USEPA received comments to the RI Report along with a revised version of the Human Health Risk Assessment (HHRA). The HHRA dated September 19, 2007 contained minor modifications to the HHRA appended to the RI Report dated August 31, 2007.

- Relative cost of the alternative;
- How much risk reduction will be achieved from implementing the alternative;
- Land use required for implementation;
- Compliance with ARARs and TBCs;
- Need for any institutional controls after alternative is implemented; and
- Other relevant information.

After comments from USEPA, the Alternatives Screening Technical Memorandum was revised and served as the basis for the next step in the FS process, a comparative analysis of remedial alternatives, Task 7.

Task 7: Detailed Analysis of Alternatives (FS Report)

Tasks 7 consisted of two tasks. The first deliverable of Task 7, the Comparative Analysis of Remedial Alternatives Technical Memorandum was initially submitted to USEPA as a draft report on May 25, 2007. Following Agency review, this document was finalized on October 5, 2007. This memorandum further evaluated the remedial alternatives that were retained from the alternatives screening. This evaluation consisted of a detailed analysis of remedial alternatives against the nine Superfund evaluation criteria, and then an analysis comparing all of these alternatives using these nine criteria as a basis for comparison. The nine Superfund criteria are categorized as threshold criteria, primary balancing criteria and modifying criteria and are further described below.

Threshold criteria, which relate to statutory requirements that each alternative must satisfy in order to be eligible for selection, include:

- Overall protection of human health and the environment, and
- Compliance with ARARs.

The *primary balancing criteria*, which are the technical criteria upon which the detailed analysis is primarily based, include:

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability, and
- Cost.

The third group, the *modifying criteria*, includes:

- State/support agency acceptance, and
- Community acceptance.

In the Comparative Alternatives Analysis, these nine evaluation criteria were applied to the remedial alternatives retained from the Alternatives Screening memo to ensure that the selected remedial alternative will:

- protect human health and the environment and meet remedial action objectives;
- comply with or include a waiver of ARARs;
- be cost-effective;
- utilize permanent solutions and alternative treatment technologies, or resource recovery technologies, to the maximum extent practicable; and
- address the statutory preference for treatment as a principal element.

This FS report, the second element of Task 7, is the culmination of the process required by the SOW. It summarizes the remedial alternatives that were retained from the Alternatives Screening Technical Memorandum (ASTM) and the detailed and comparative evaluation of these retained alternatives that was conducted in the Comparative Analysis of Alternatives Technical Memorandum (CAATM). Both documents were submitted for USEPA review, and USEPA provided comments both initial and revised draft documents. USEPA comments were incorporated into both technical memoranda. As described in an August 17, 2007 letter from USEPA, EPA modified the ASTM pursuant to Subparagraph 21(c) of the AOC. This modified document was attached to that letter. The final ASTM was submitted on September 7, 2007. The revised draft CAATM was subsequently submitted on October 5, 2007 in accordance with deadlines established in the AOC. There has been no formal response received from the USEPA since that revised draft was submitted. This revised draft FS Report incorporates this latest version of the CAATM as Appendix A2. .

All potential remedial alternatives evaluated in this report were evaluated in the accordance with USEPA guidance (USEPA 1988). Remedial alternatives evaluated in this FS are summarized below.

Soil

The following eight alternatives were retained for soil:

Alternative S-1	No action
Alternative S-2:	Containment using engineered surface barriers;
Alternative 3-A:	Limited removal and off-site disposal;
Alternative S-3B:	Unlimited removal and off-site disposal;
Alternative S-4A:	Limited removal and on-site disposal;
Alternative S-4B:	Unlimited removal and on-site disposal;
Alternative S-5A:	Limited removal and on-site thermal treatment;
Alternative S-5B:	Limited removal and off-site incineration; and
Alternative S-6	Limited removal and on-site soil washing.

The no action alternative (***Alternative S-1***) while costing little to nothing will not provide any long-term protection. Containment using surface barriers (***Alternative S-2***) will prevent direct contact with surface contamination thereby reducing the risk to human health, but will need to be used in combination with other remedial alternatives for soil and groundwater to optimize effectiveness. Unlimited removal and off-site disposal (***Alternative S-3B***) will provide the highest long-term protection. However, this benefit is outweighed by the costs associated with this alternative, and potential short term and long term impacts during implementation. Although removal of all wood waste and fill soil from Kreher Park was evaluated as a potential remedial response, it may not be acceptable to the community if it results in the loss of future use of the park (i.e. restoration as shallow lakebed or wetland). Additionally, potential remedial alternatives requiring limited removal are more cost effective. Limited removal and off-site disposal (***Alternative S-3A***), limited and unlimited removal and on-site disposal (***Alternatives S-4A and S-4B***), and limited removal and thermal treatment (***Alternative S-5A***) will provide long-term protection with minimal short-term implementation issues. Unlimited removal and on-site disposal (***Alternative S-4B***) and off-site incineration (***Alternative S-5B***) would also provide long-term protection with minimal short-term implementation issues, but at a much higher cost. A pilot test would be needed to further evaluate the feasibility of limited removal and on-site soils washing (***Alternative S-6***) to ensure its effectiveness, but it could also provide long-term benefits with minimal short-term implementation issues.

Groundwater

The following nine alternatives were retained for groundwater:

Alternative GW-1:	No Action;
Alternative GW-2:	Containment using surface and vertical barriers;
Alternative GW-3:	In-situ Treatment using ozone sparge;
Alternative GW-4:	In-situ Treatment using surfactant injection and removal using dual phase recovery;
Alternative GW-5:	In-situ treatment using PRB walls:
Alternative GW-6:	In-situ treatment using chemical oxidation;
Alternative GW-7:	In-situ treatment using electrical resistance heating;
Alternative GW-8:	In-situ treatment using steam injection, and,
Alternative GW-9:	Groundwater extraction.

Institutional controls and monitored natural attenuation were not retained for screening as stand alone remedial responses; both technologies were evaluated as elements of other active remedial alternatives for soil and groundwater. Surface barriers, vertical barriers, and in-situ remedial responses that can also be used for soil were combined with other potential remedial technologies for soil and shallow groundwater contamination.

Groundwater remedial alternatives evaluated in this report include no action, containment, in-situ treatment, and removal technologies identified in the Alternative Screening Technical Memorandum (URS 2007a). No Action (***Alternative GW-1***) was also retained as required by the

NCP as a basis for comparing the other alternatives. Containment alternatives include ***Alternatives GW-2A and 2B*** (containment using surface and vertical barriers; Alternative GW-2A includes partial caps at Kreher Park, and Alternative GW-2B includes a cap for the entire park) and ***Alternatives GW-5*** (in-situ treatment using PRB walls). If implemented, ***Alternatives GW-5*** would be used with ***Alternatives GW-2A or GW-2B*** to minimize long-term treatment of shallow groundwater. Although costs to implement Alternative GW-2B and GW-5 are higher, long term operation maintenance costs would be reduced. Based on cost estimates presented in this report, the PRB wall ***(Alternative GW-5)*** will yield the lowest cost for containment at Kreher Park. ***Alternatives S-2A and S-2B*** yield higher costs due to long-term treatment of groundwater removed from the contained area. The remaining in-situ treatment alternatives include the following:

Alternative GW-3:	In-situ Treatment using Ozone Sparge;
Alternative GW-4:	In-situ Treatment using Surfactant Injection and Removal using Dual Phase Recovery;
Alternative GW-6:	In-situ Treatment using Chemical Oxidation;
Alternative GW-7:	In-situ Treatment using Electrical Resistance Heating; and,
Alternative GW-8:	In-situ Treatment using Dynamic Underground Stripping/Steam Injection.

Removal technologies evaluated for groundwater include dual phase recovery and removal using extraction wells. Dual phase recovery was evaluated with ***Alternative GW-4*** (in-situ treatment using surfactant injection), and removal using groundwater extraction wells (***Alternatives GW-9A and GW-9B)*** was evaluated as a stand alone remedial technology; ***Alternative GW-9A*** includes continued operation of the existing system, and ***Alternative GW-9B*** includes the installation of additional groundwater extraction wells. However, all in-situ remedial technologies evaluated may require groundwater extraction in some capacity.

Containment is not a feasible remedial alternative for the Copper Falls aquifer. The remaining groundwater remedial alternatives could be used for shallow groundwater in the upper bluff area and Kreher Park and for the Copper Falls aquifer. Buried structures in the upper bluff area and the wood waste layer at Kreher Park may limit the effectiveness of in-situ treatment in these areas. If removal and disposal (on- or off-site) or on-site treatment is selected as a remedial response for soil, or if containment is selected for shallow groundwater, in-situ treatment and or removal will not be necessary for soil and shallow groundwater contamination. However, one or more of the in-situ or removal technologies evaluated in this report will be required for the Copper Falls aquifer.

Sediment

Five alternatives were retained for sediment:

Alternative SED-1:	No Action;
Alternative SED-2:	Limited dredging and containment within an on-site CDF;
Alternative SED-3:	Dredging to a four foot depth and containment with a subaqueous cap;
Alternative SED-4:	Dredge all sediment above the Remedial Action Objective; and
Alternative SED-5	Dry Excavation.

Alternative SED-1 (no action), while costing little to nothing, would not provide any long-term protection, and therefore should not be considered. ***Alternative SED-2*** would provide the most long-term benefit with the fewest short-term technical implementation and short term impacts of remedy (due to volatilization) issues. However there would be permanent loss of approximately seven acres of shallow lake bed habitat and administrative implementability may be difficult.

With ***Alternative SED-3***, approximately 78,000 cubic yards would be removed from the environment and either treated or disposed in a NR500 landfill. However, a subaqueous cap at the shoreline may be considered less permanent than a CDF. In addition the requirement for more debris removal and for sediment treatment as compared to SED-2 increases the short term risk of implementation of this alternative due to the likelihood that these activities would result in release of potentially harmful volatile emissions. As with ***Alternative SED-2***, administrative implementability may be difficult, although no lake bottom would be lost since the top of the cap would be designed to provide a fully functioning benthic habitat and not change the present bathymetry.

Alternative SED-4 would offer greater protection of human health and the environment than ***Alternatives SED-2 and SED-3***, but at a cost that is almost 30% greater than ***Alternative SED-2 and SED-3***. If all dredging is conducted mechanically and there is no need for thermal treatment ***Alternative SED-4*** is approximately $11,000,000 greater than ***Alternative SED-3*** ($41,300,000 versus $30,100,000). However if hydraulic dredging is required and there is a need to thermally treat the sediments the cost for ***Alternative SED-4*** could be as much as $20,000,000 greater than ***Alternative SED-3*** ($61,100,000 versus $41,700,000) In addition the requirement for substantially greater debris removal and for treatment of almost twice as much sediment under ***Alternative SED-3*** results in this alternative having the greatest short term risk of implementation due to the likelihood that these activities would result in release of potentially harmful volatile emissions. Unlike ***Alternatives SED-2 and SED-3***, ***Alternative SED-4*** does not have to be approved by the Governor and Legislature.

Alternative SED-5 is similar to SED-4 in achieving greater protection of human health and the environment. However, this alternatives is substantially more expensive than Alternative SED-4 (from approximately $25,000,000 to $33,000,000 or about 65% more expensive using similar sediment treatment) and also presents potentially greater risk to human health, because of the need to work behind barriers engineered to keep out the waters of Lake Superior and because the project duration is estimated to be at least twice as long. If SED-5 were implemented the use of Kreher Park by the public would be precluded for almost four years which is two years more than with other alternatives..

If both ***Alternative SED-4*** and soil ***Alternative S-3B*** are selected, as much as 350,000 cubic yards of sediment and soil or more may require disposal. Given that outcome, it may be cost effective to site a private NR500 landfill in the Ashland area on property owned or purchased by NSPW.

Based on this evaluation, ***Alternative SED-4*** would provide the most long-term benefit at the least cost and with the fewest short-term technical implementation issues.

Introduction

1.0 Purpose and Organization of Report

This Feasibility Study (FS) report is the culmination of the feasibility process for the Ashland/Northern States Power Lakefront Superfund Site (Site). It was prepared consistent with the Statement of Work (SOW) appending Administrative Order on Consent CERCLA Docket No. V-W-04-C-764. As required by Tasks 5 and 7 of the SOW this FS report was preceded by the submission of three technical memoranda:

1) A Remedial Action Objectives Technical Memorandum (RAOTM): Finalized on June 6, 2007;
2) An Alternatives Screening Technical Memorandum (ASTM): Finalized on September 7, 2007; and
3) A Comparative Analysis of Remedial Alternatives (CAATM): Finalized on October 5, 2007.

The RAOTM was included as Appendix A of the RI Report. The ASTM is included in Appendix A1, and the CAATM is included in Appendix A2 of this FS Report.

In addition four treatability studies were conducted as part of the FS process. These treatability studies were proposed consistent with Task 6 of the SOW and included:

1) SITE demonstration project for treatment of groundwater;
2) Cap Flux Testing;
3) Bench Scale Air Emissions Testing; and
4) Multiphase Flow and Consolidation Testing.

A report describing activities completed during the SITE demonstration is included in Appendix B1. The Cap Flux Testing, Bench Scale Air Emission, and Multiphase Flow and Consolidation Testing report are included as Appendices B2, B3, and B4, respectively.

This FS report summarizes the development and screening of the remedial alternatives, presents the detailed analysis of remedial alternatives that were presented in the Comparative Analysis Technical Memorandum, and considers how the treatability studies influences the selection of remedial technologies. Section 9.0 includes an evaluation of integrated remedial responses completed for each area of concern to provide information EPA will need to prepare relevant sections of the Record of Decision (ROD) for the Site

1.1 Site Description

The Site consists of property owned by Northern States Power Company – Wisconsin (NSPW, a Wisconsin corporation doing business as Xcel Energy, which is a subsidiary of Xcel Energy

Inc.), a portion of Kreher Park[2], and sediments in Chequamegon Bay of Lake Superior which is an offshore area adjacent to Kreher Park. The Site is located in Section 33, Township 48 North, Range 4 West in Ashland County, Wisconsin, as shown on Figure 1-1. Existing site features showing the boundary of the site are shown on Figure 1-2, and former MGP features are shown on Figure 1-3.

The NSPW service center is located at 301 Lake Shore Drive East in Ashland, Wisconsin. The facility lies approximately 1,000 feet southeast of the shore of Chequamegon Bay of Lake Superior. The NSPW property is occupied by a small office building and parking lot fronting on Lake Shore Drive, and a larger shop/garage building and parking lot area located south of St. Claire Street between Prentice Avenue and 3rd Avenue East. There is also a gravel-covered storage yard area north of St. Claire Street between 3rd Avenue East and Prentice Avenue, and a second gravel-covered storage yard at the northeast corner of St. Claire Street and Prentice Avenue. A large microwave tower is located on the north end of the storage yard. The office building and vehicle maintenance building are separated by an alley. The area occupied by the buildings and parking lots is relatively flat, at an elevation of approximately 640 feet above mean sea level (MSL). Surface water drainage from the NSPW property is to the north. Residences bound the site east of the office building and the gravel-covered parking area. Our Lady of the Lake Church and School is located immediately west of Third Avenue East. Private homes are located immediately east of Prentice Avenue. To the northwest, the site slopes abruptly to the Canadian National (formerly known as Wisconsin Central Limited) Railroad property at a bluff that marks the former Lake Superior shoreline, and then to the City of Ashland's Kreher Park, on the shore of Chequamegon Bay.

[2] Reference to this portion of the Site as Kreher Park developed colloquially over the course of this project. Kreher Park consists of a swimming beach, a boat landing, an RV park and adjoining open space east of Prentice Avenue, lying to the east of the study area of the Site. For purposes of this document and to be consistent with past reports referenced, the portion of the Site to the west of Prentice Avenue, east of Ellis Avenue and north of the NSPW property is referred to as the "Kreher Park Area" or simply Kreher Park.

2.0 Summary of Community Relations Support

USEPA has delegated lead for the Community Relations aspects of the RI/FS to Wisconsin Department of Natural Resources (WDNR). NSPW has pledged its support in staffing and assisting in community outreach activities for the RI/FS process, as contemplated in the SOW.

USEPA and the Wisconsin Department of Natural Resources (WDNR) held a community workshop for residents in the Ashland area on October 25, 2007. The purpose of the work shop was to identify the outcomes or characteristics of a cleanup remedy most acceptable to the community. A summary report of the workshop prepared by USEPA is included in Appendix C.

3.0 Summary of the Remedial Investigation

3.1 Summary of RI Findings

Site characterization began in 1989 when apparent contamination was discovered at Kreher Park. Several phases of investigation were subsequently completed at Kreher Park and at the adjacent upper bluff area including a Remedial Investigation (RI) completed between March and November 2005. All historic and RI investigation results were presented in the *Remedial Investigation Report* dated August 31, 2007. As described in that report, the primary contaminants at the Site are derived from tar compounds,[3] including volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbon (PAH) compounds. Additionally, some free-phase hydrocarbons product (free product) derived from the tars is present as a non-aqueous phase liquid (NAPL), and have impacted soils, groundwater, and offshore sediments. Free-product referenced in this document includes both light non-aqueous phase liquid (LNAPL) and dense non-aqueous phase liquid (DNAPL).

DNAPL has been encountered in the upper reaches of a filled ravine near the former MGP facility on the NSPW property, at isolated areas at Kreher Park including the former "seep" area, in the offshore sediments, and in the upper elevations of the Copper Falls Formation, which behaves as a confined aquifer near the former MGP at the upper bluff area. DNAPLs encountered in the filled ravine (near the former MGP facility) and at isolated areas at Kreher Park were encountered at the base of these fill units overlying the Miller Creek Formation. The Miller Creek Formation is the confining unit for the underlying Copper Falls aquifer (see Section 3.1.2). LNAPLs were also observed across much of Kreher Park[4] as oily sheen in the underlying wood waste layer encountered during a test pit investigation at the Park.

Although DNAPL has also been encountered in off-shore sediment, it is less defined than on-shore locations due to the dynamic conditions in the affected sediments. DNAPLs in the deep aquifer correspond to high levels of VOCs in groundwater (> 50,000 µg/L), which is surrounded by a dissolved phase contaminant plume that extends north from the NAPL area in the direction of groundwater flow. A description of the site history, site setting, nature and extent of soil, groundwater, and sediment contamination from the RI follows.

[3] The term "tar" is used generically in this document to refer to a suite of VOC and PAH compounds the sources of which are the former MGP and other lakefront industrial operations including wood treatment activities.

[4] Fill used to construct Kreher Park consists of several feet of clean fill soil overlying several feet of wood waste. This wood waste layer consists of slab wood, logs, and other wood debris submerged near the shoreline to form a platform for lumbering operations in the late 19th century. Native soil units beneath the wood waste layer consist of a thin sand unit (beach sand unit) and the Miller Creek formation. The Miller Creek behaves as a confining unit for the underlying Copper Falls aquifer.

3.1.1 Site History

The Ashland NSP Lakefront Superfund Site (the "Site") consists of land and sediment located along the shore of Lake Superior, in Ashland, Wisconsin. The Site contains: (i) property owned by Northern States Power Company, a Wisconsin corporation (d.b.a. Xcel Energy, a subsidiary of Xcel Energy Inc. ("NSPW")); (ii) a portion of Kreher Park[5], a City owned property fronting on the bay which includes the former City Wastewater Treatment Plant (WWTP) structure; (iii) an inlet area containing contaminated sediment directly offshore from the former WWTP, and (iv) Our Lady of the Lake Church/School, as well as private residences. The Site is bounded by US Highway 2 (Lake Shore Drive) to the south, Ellis Avenue and its extension to the City marina to the west, Prentice Avenue and its extension to a boat launch to the east, and a line between the north termini of the marina and the boat launch to the north.

The NSPW property, located on an upper bluff fronting on Kreher Park, is the site of a former manufactured gas plant (MGP) that operated between 1885 and 1947. The MGP began as a small producer of gas for street lighting and other residential and commercial uses, and expanded over the next several decades. The plant predominantly employed the carburetted water gas process to manufacture gas.[6] The plant ceased operation in 1947 when the facility was dedicated to propane distribution. Since that time, the property has been used as an electrical repair shop and equipment storage facility first for Lake Superior District Power, followed by its current successor, NSPW.

Kreher Park includes lands formed from the filling of the bay during the late 1800s and early 1900s when the area was the site of major lumbering operations. These operations began in 1884 with the Barber Mill, which shortly changed ownership to the Sutherland Mill and then the Pope Mill over the succeeding 17 years. In 1901, the John Schroeder Lumber Company acquired the property and continued to expand lumber operations and shipping facilities on the lakefront. Schroeder's operations may have included wood treatment. Schroeder ceased operation around 1931, but owned the property until 1939. Ashland County then took ownership through a bankruptcy action in 1941, and subsequently transferred the title to the City of Ashland in 1942.

The lakefront property was utilized for the uncontrolled disposal of MGP waste (primarily tar through the ravine). Solid wastes, primarily demolition debris, were disposed along the western

[5] Kreher Park consists of a swimming beach, a boat landing, an RV park and adjoining open space east of Prentice Avenue, east of the subject study area of the Site. For purposes of this RI report and to be consistent with past documents, the portion of the Site to the west of Prentice Avenue, east of Ellis Avenue and north of the NSPW property is referred to as the "Kreher Park Area" or simply Kreher Park.

[6] LSDP and its predecessor records indicate that the MGP produced water gas exclusively during its tenure. An exception is for the year 1917, when records indicate that less than 15% of the total gas production was recorded as "coal gas." Brown's Directories for the same period (1913 – 1916) records that the Ashland MGP "will construct coal gas plant of 14,000,000 cf (14,000 mcf) capacity per annum." There is no further mention of this facility in Brown's beginning in 1917 (A history of Ashland MGP Tar Generation Records is included in Appendix D of the March 1999 Ashland/NSP Lakefront Feasibility Study report.)

side of the property in the 1940s. The City's waste water treatment plant (WWTP) was constructed in the early 1950s, expanded in the 1970s and continued to operate through the early 1990s. Since the City's ownership, numerous construction activities that resulted in substantial filling operations continued. These included the aforementioned waste disposal operation, construction in the early 1950s (and expansion in the early 1970s) of the WWTP, and construction of the City's marina in the mid 1980s. Marina construction included construction of boat slips and the extension of Ellis Avenue, which forms the western boundary of the Site.

In 1989 during exploratory drilling in preparation for another planned WWTP expansion, the City encountered coal tar contamination in the area south of the plant. The City notified the Wisconsin Department of Natural Resources (WDNR). The plant was ultimately relocated southeast of the City. Since the early 1990s, the WWTP has remained dormant. Since that time, the Kreher Park area has been used only for minor recreational purposes (a one-time miniature golf facility) and dry-dock marina boat storage.

The discovery of contaminants at Kreher Park initiated several investigations that culminated in the identification by the WDNR of the former MGP, and the naming of NSPW a potentially responsible party (PRP) for the MGP wastes/contamination at the site. The City of Ashland and an operating railroad were also named as PRPs for solid wastes disposed on their properties, in the mid to late 1990s. The WDNR and NSPW subsequently performed a series of independent investigations to assess the extent of contamination at Kreher Park and the NSPW property, respectively. In 1998 a local environmental group petitioned the United States Environmental Protection Agency (USEPA) to evaluate the Site for scoring on the national priorities list (NPL) for Superfund. The site was nominated in 2000, and formally added to the NPL in 2002. NSPW subsequently signed an administrative order on consent (AOC) with USEPA in 2003 to conduct a remedial investigation/feasibility study (RI/FS) at the Site. The purpose of this program is to fill data gaps identified from earlier investigations, and develop remedial alternatives for the Site.

A Work Plan for a supplemental site investigation was submitted and approved by USEPA in February 2005 fulfilling Task 1 of the AOC. This investigation was completed in 2005. Results of all historical and supplemental investigations were presented in a Remedial Investigation Report finalized in August 2007; these activities fulfilled Tasks 3 and 4, respectively, of the AOC. Potential remedial responses were screened in the Alternative Screening Technical Memorandum finalized in September 2007, which fulfilled Task 5 of the AOC. Treatability tests were completed in 2007 in accordance with USEPA approved work plans, fulfilling Task 6 of the AOC. Potential remedial responses were further evaluated in the Comparative Alternatives Analysis Technical Memorandum (CAATM) in accordance with Task 7 of the AOC. A revised draft of the CAATM was submitted for Agency review on October 5, 2007. The draft FS Report was submitted on October 29, 2007. This revised draft FS Report presents a summary of the RI Report, treatability study results, and detailed analysis of potential remedial responses.

3.1.2 Site Setting

Site geologic conditions have been determined from previous investigations along with supplemental investigations completed during the RI performed during 2005. Historic investigations included the visual classification of subsurface soil units from numerous soil borings, monitoring well boreholes and exploration test pits. Supplemental investigations completed for the RI included the installation of additional monitoring wells, the collection of surface and subsurface soil samples from borings and test pits, and a downhole geophysical survey. Geologic units investigated at the Site include the Miller Creek Formation and underlying Copper Falls Formation. Fill soil units were also encountered at the upper bluff and at Kreher Park. At the upper bluff area, fill soil was encountered in a former ravine that dissected the Miller Creek Formation in the vicinity of the former MGP facility. Kreher Park consists of fill material used to fill the former lakebed.

Hydrogeologic units correspond to geologic units identified during previous phases of investigation. The uppermost water bearing unit at the upper bluff area includes the Miller Creek Formation. Groundwater is also encountered in the fill material used to backfill the former ravine that dissected the Miller Creek Formation in the vicinity of the former MGP facility. The uppermost water bearing unit at Kreher Park consists of fill material used to fill the former lakebed; this fill material overlies the Miller Creek Formation. The fine-grained low permeability Miller Creek Formation creates an aquitard overlying the Copper Falls aquifer, behaving as a confining unit.[7]

Previous investigations have identified groundwater contamination in the ravine fill, the Kreher Park fill and the underlying Copper Falls aquifer. Groundwater contamination in the underlying Copper Falls aquifer is the result of former MGP operations. Contaminants, including nonaqueous phase liquids (NAPL) migrated to the underlying Copper Falls aquifer in the vicinity of the former MGP facility where the Miller Creek Formation lacks plasticity and where vertical hydraulic gradients indicate downward flow in the Copper Falls aquifer. These migration pathways may have been exacerbated by construction operations during the early life of the MGP. Strong upward gradients have likely limited the vertical migration of contaminants at down gradient locations north of this area. The transition from downward to upward gradients within the Copper Falls aquifer occurs at the alley immediately south of the NSPW service center. Site investigation results indicate that contaminants in the Copper Falls aquifer have migrated laterally along the interface between the Copper Falls aquifer and overlying Miller Creek aquitard.

[7] This document utilizes the term “aquifer” when referring to the hydrogeologic conditions in the Copper Falls Formation; similarly, it uses the term “aquitard” when referring to hydrogeologic conditions in the Miller Creek Formation.

3.1.3 Nature and Extent of Contamination

The contaminants at the Site are typical manufactured gas plant wastes. These include volatile organic compounds (VOCs) and a subgroup of the larger list of semivolatile organic compounds (SVOCs) referred to as polycyclic aromatic hydrocarbons (PAHs). The most abundant compounds from each of these groups include benzene (VOCs) and naphthalene (PAHs). Soils and groundwater at the Site are contaminated with these compounds, as are the offshore sediments in the affected inlet. Additionally, tar is present as dense non-aqueous phase liquids (DNAPLs) in the upper reaches of the filled ravine on the NSPW property south of St. Claire Street, and in the vicinity of a clay pipe encountered at the base of the ravine on the north side of the Street. It is also present at isolated areas at Kreher Park, including the former “seep” area and north of the former WWTP, in an area parallel to the shoreline extending across the historic lakebed northwest of the former WWTP, and in the upper elevations of the deep Copper Falls aquifer. The DNAPL in the deep aquifer has resulted in a dissolved phase contaminant plume that extends north from the DNAPL zone in the direction of groundwater flow, toward the bay. However, the thick clay aquitard (the Miller Creek Formation) provides a hydraulic barrier that separates the deep aquifer from the shallow groundwater encountered in Kreher Park fill and the bay waters in the area of the affected inlet. This separation is demonstrated by the strong artesian pressures measured at Kreher Park wells that are screened in the Copper Falls aquifer.

NSPW implemented interim removal actions in 2000 and 2002 to mitigate exposure risks to contaminants and to recover tar from the deep aquifer. A low-flow pumping system currently extracts tar from the deep aquifer, treating the entrained groundwater before discharging it to the City of Ashland’s sanitary sewer. Additionally, NSPW installed an extraction well at the base of the former filled ravine that was the source of the seep discharge at Kreher Park. This extraction well was part of a larger interim action that included excavation of contaminated materials at the former seep area and placement of a low-permeability cap to eliminate the intermittent seep discharge and mitigate environmental exposure of the associated contaminants.

The remaining sources of contamination at the Site consist of discrete DNAPL zones derived from the tars that within each of the following locations:

1. In the filled ravine on the NSPW property;
2. At isolated areas at Kreher Park including the former “seep” area and former coal tar dump area;
3. In the offshore sediments; and
4. In the upper elevations of the deep Copper Falls aquifer.

The lateral extent of soil contamination identified in the upper bluff area, primarily in the backfilled ravine, and throughout the Kreher Park fill soil is shown in Figure 3-1. The lateral extent of shallow and deep groundwater contamination is shown on Figure 3-2. The area of impacted sediment is shown on Figure 3-3. The lateral extent of DNAPL in the filled ravine and Copper Falls aquifer is also shown on Figure 3-4, and the lateral extent of DNAPL at Kreher Park is shown on Figure 3-5. A description of the nature and extent of contamination in each area follows.

Filled Ravine

DNAPL has been encountered at the base of the filled ravine located south of St. Claire Street beneath the NSPW service center building and adjacent asphalt courtyard area. Part of this building includes an older section incorporating the former MGP building, and gas holders for the MGP are located within the filled ravine (see Figure 1-3). The depth of the center of the ravine in this area ranges from 15 to 20 feet below ground surface. The former ravine dissected the Miller Creek formation, which is the uppermost unconsolidated geologic unit in the Ashland area. This low permeability silty-clay/clayey silt unit is encountered at the base and flanks of the filled ravine. A perched aquifer has formed in the filled ravine because the fill material, which includes cinders, debris, and other locally derived detritus, is more permeable the surrounding native soil unit. Groundwater encountered within four to six feet of the ground surface is in hydraulic connection with the regional water table that extends across Site within the Miller Creek Formation.

Soil and groundwater in the filled ravine are contaminated largely by contact/proximity with the DNAPL on the south side of St. Claire Street. Contamination within the filled ravine down gradient from this area (beneath St. Claire and on the north side of St. Claire) has also been encountered. DNAPL was encountered in and around a 12-inch clay tile encountered at the base of the filled ravine on the north side of St. Claire Street during a 2001 investigation (see Figure 3-4). This clay tile was found to extend beyond the mouth of the filled ravine to the former seep area at Kreher Park. This discharge was eliminated in 2002 with the installation of an interception well (EW-4) at the mouth of the former ravine following the removal of contaminated soil and cap installation at the seep area. Although DNAPL or LNAPL has not been encountered in EW-4, groundwater currently extracted from the filled ravine is conveyed to the existing tar removal system for treatment prior to discharge to the sanitary sewer.

Kreher Park

Based on current data, the impacted area of Kreher Park consists of a flat terrace adjacent to the Chequamegon Bay shoreline. The surface elevation of the park varies approximately 10 feet, from 601 feet above MSL, to about 610 feet above MSL at the base of the bluff overlooking the park. The bluff rises to an elevation of about 640 feet above MSL, which corresponds to the approximate elevation of the NSPW property. The lake elevation has historically fluctuated about two feet, from 601 to 603 feet above MSL[8]. At the present time, the park area is predominantly grass covered. A gravel overflow parking area for the Ashland Marina occupies the west end of the property, while a miniature golf facility formerly occupied the east end of the site. The City of Ashland former waste water treatment plant (WWTP) and associated structures front the shoreline on the north side of the property. The impacted area of Kreher Park occupies approximately 13 acres and is bounded by Prentice Avenue and a jetty extension of Prentice

[8] Lake Superior has experienced historic low water levels since 2005. These historic low elevations have rebounded several inches in recent months (spring 2008) but remain below the normal range of 601 – 603 msl.

Avenue to the east, the Canadian National Railroad to the south, Ellis Avenue and the marina extension of Ellis Avenue to the west, and Chequamegon Bay to the north.

At Kreher Park, DNAPL is present at the seep area and in the former coal tar dump area north of the mouth of the filled ravine at Kreher Park. DNAPL contaminated soil above the wood waste layer was removed from the seep area in 2002 and replaced with clean fill. In the former coal tar dump area, DNAPL contaminated soil was encountered beneath several feet of clean fill overlying the wood waste layer. In both areas, DNAPL remains in the underlying wood waste layer, which underlies the entire Park. The former coal tar dump area and lateral extent of DNAPL at Kreher Park is shown on Figure 3-5.

Although the lateral extent of the DNAPL zone is limited, contaminated soil and groundwater conditions are widespread across the entire park area. Elsewhere at Kreher Park, contaminants were encountered in the wood waste layer beneath several feet of clean surficial soil. A LNAPL sheen was also observed in this wood waste layer, which was encountered at test pits locations throughout Kreher Park during the test pit investigation. Areas at Kreher Park with LNAPL yielded total VOC concentrations in groundwater below 5,000 µg/l significantly lower than VOC concentrations associated with DNAPL (> 50,000 µg/l).

Offshore Sediment

The offshore area with impacted sediments is located in a small bay created by the Prentice Avenue jetty and marina extensions previously described. For the most part, contaminated sediments are confined within this small bay by the northern edge of the line between the Prentice Avenue jetty and the marina extension. The affected sediments consist of lake bottom sand and silts, and are mixed with wood debris likely originating from former log rafting and lumbering operations. The wood debris layer is up to seven feet thick in areas, with an average thickness of nine inches. Wood debris overlays approximately 95% of the impacted sediments. Based on current data, the entire area of impacted sediments encompasses approximately sixteen acres based upon a Preliminary Remediation Goal (PRG) for sediment of 9.5 µg PAH /g @0.415% OC.

NAPL is also present in some sediments in the offshore zone along the Kreher Park shoreline, mainly at the sand/wood waste interface (historic lakebed). The most NAPL is in the area between the marina and an area north of the former WWTP from 100 to 300 feet from the shore. In this area NAPL is found at depths up to four feet below the sediment/water interface in this zone. A separate NAPL area is found at depths up to 10 feet between the former WWTP and the boat launch.

Copper Falls Aquifer

A DNAPL mass is present underlying the Miller Creek Formation in the same area of the NSPW service center. This material is found within the upper reaches of the Copper Falls aquifer, a sandy, coarse grained unit. DNAPL extends from depths of approximately 30 to 70 feet. The greatest thickness of DNAPL is present directly south of St. Claire Street within the main access drive of the NSPW service center. It thins in all directions from this area. The lateral extent of DNAPL in the underlying Copper Falls aquifer is shown on Figure 3-4.

NSPW has maintained a free product recovery system consisting of three extraction wells since the system was installed in 2000. Although this is a low flow pumping system, groundwater is used as a carrier to remove free product (NAPL), which necessitates the removal of groundwater. Through April 2008, 1.98 million gallons of contaminated groundwater have been removed from the Copper Falls aquifer. A significant percentage (99.3 percent) of this volume extracted is water. An oil water separator is used to separate NAPL from water. Contaminated water is then treated by carbon filtration prior to discharge to the sanitary sewer system. NAPL is placed in a storage tank and periodically transported off-site for disposal. Through April 2008, approximately 9,700 gallons of NAPL has been separated from groundwater for off-site disposal (0.7% of the total volume removed).

Although the carburetted water gas process used by the former MGP likely generated tar-water emulsions (typically 10% oil/tar and 90%water), NAPL with low water content is separated from the recovered groundwater. Analysis of free product/NAPL ("oil") samples collected from the storage tank yielded NAPL water contents of 0.17 and 4.34 percent[9].

Hydrogeologic conditions at the site have restricted the migration of contaminants in the underlying Copper Falls aquifer. The fine grained low permeability Miller Creek Formation behaves as a confining unit (aquitard) for the Copper Falls as indicated by strong upward vertical gradients that increase with depth in nested wells screened in this unit. These strong upward gradients have resulted in the migration of the plume in the upper Copper Falls along the interface with the Miller Creek. Although it has been determined that groundwater flow in the upper bluff area is to the north toward Chequamegon Bay, the lateral extent of contamination beneath Kreher Park is limited by a stagnation zone located between the shoreline and the bluff face. This stagnation zone has formed in response to an increase in the thickness of the Miller Creek aquitard toward the shoreline, which results in and increase in the artesian pressure in the underlying confined aquifer. Wells screened in the aquifer north of the bluff face forming the boundary between Kreher Park and the NSPW property are flowing (artesian) wells. This stagnation zone is characterized by a trough of low artesian pressure located near the center of the Park between the shoreline and at the bluff face. In the deeper portions of the Copper Falls aquifer groundwater likely flows beneath Chequamegon Bay. Additional wells may be needed

[9] Samples D-1 and D-2 yielded water contents of 43,400 and 1,700 ug/g, respectively, by the Karl Fisher titration method, which is commonly used to accurately measure water content in oil. Laboratory reports for these samples are included in Appendix D-4 of the RI Report.

to ensure that contaminants are not migrating beyond the shoreline in deeper portions of the Copper Falls.

3.1.4 Contaminant Fate and Transport

The source of the contamination at the Site was caused primarily by the MGP and other multiple industrial activities that began in the 1880's and continued until the mid 20th century. Although contaminant sources were no longer active after that time, continued filling activities further dispersed these contaminants. However, no large scale activities capable of mobilizing contaminants, or filling activities that add contaminant mass to the source areas have occurred at the Site since the closure of the WWTP in the early 1990s.

The primary source of contamination at the upper bluff/filled ravine, Kreher Park, Copper Falls aquifer and Chequamegon Bay is from the historic MGP operations. Contamination likely resulted from discharge of waste tars generated from the carburetted water gas manufacturing process. The tar material accumulated at the base of the ravine fill in the immediate area of the MGP facilities south of St. Claire Street and was dispersed throughout the inlet prior to filling at Kreher Park.

The tar has migrated into the bay and contaminated the Chequamegon Bay area. The migration of this material to the Copper Falls aquifer also occurred where the overlying Miller Creek Formation is less plastic and hydrogeologic conditions allow downward flow conditions. This area is south of the alley behind the present NSPW service center.

Waste tars released during MGP operations migrated through the ravine fill and the buried clay tile to the base of the former ravine. The source of the NAPL at the seep was the MGP. The tile was likely part of a sewer system installed contemporaneously during the early operation of the MGP. A 1902 City of Ashland sewer ordinance required the underground discharge of MGP wastes, and this pipe may have been installed as a result. However, the NAPL mass found south of St. Claire Street indicates this material was released at least in part and not entirely captured by this pipe system. Following backfilling of the ravine, releases of NAPL likely continued through the clay tile pipe. This material migrated to the downstream end of the tile, likely connected to a second tile system identified during the 2005 RI. This tile paralleled the bluff face and was traced to the location of an upstream inlet of a former open sewer identified at the west side of Kreher Park. Although actual records have not been recovered, this pipe network was likely part of a larger sewer system abandoned following cessation of industrial activities at the park in the late 1930s, when the open sewer was filled. Once the open sewer was abandoned, NAPL then discharged through breeches in the pipe network, such as at the seep.

The source of NAPL to the sediments likely resulted from a combination of effects. Direct discharge of wastes through the open ravine to the inlet prior to its filling is one source. Discharges of wastes from the open sewer prior to its filling and abandonment constitute another source. The wastes came primarily from the MGP, and potentially from other upland locations connected to the open sewer. Additionally, based on the distribution of NAPL in the sediments other discharge points in addition to the open sewer could be present. It is likely that the distribution of this material has been affected by construction and filling activities that continued following cessation of other lakefront operations.

The highest levels of VOC contaminants at Kreher Park are found at areas corresponding to NAPL zones. These are comparable with levels near other NAPL zones at the upper bluff/filled ravine and Copper Falls aquifers. The levels are consistent for both soil and groundwater. Because of the high mobility and high solubility of the VOCs, the high permeability/flat horizontal groundwater gradient has led to widespread VOC contamination in groundwater at Kreher Park. However, these levels are generally an order of magnitude lower than samples collected near the NAPL areas.

In contrast, the soil data from Kreher Park show the opposite relationship regarding PAHs, with an order of magnitude increase in PAH levels across the majority of the park compared to the upper bluff/filled ravine. The PAHs are less mobile and less soluble compared to the VOCs, degrading more slowly. This chemical behavior combined with the physical characteristics in the fill material have created conditions for the PAHs to remain present and at similar levels in the fill since they were first released. The highest levels are most pronounced in the area of the former coal tar dump. Another potential source is the off-loading of fuel feedstocks for other raw materials to support lakefront industrial activity.

Contaminants in the affected sediments likely originated from a variety of sources. One likely source may have been the open sewer when it was functional.

3.1.4 Conceptual Site Model

This section develops a conceptual site model (CSM) for the Site with regard to historical perspective regarding current contaminant disposition. This overview builds upon the previous information discussed to construct this model. The information presented is based on the historical record gathered from maps, physical and forensic analyses, eyewitness accounts and other documents. It is intended to provide a comprehensive interpretation of contaminant sources and present conditions based on previously developed as well as the latest data developed during the 2005 RI.

3.1.4.1 Historical Setting Summary

The MGP was constructed on the east flank of the former ravine in the mid 1880s. Contemporaneously, lumber operations at the lakefront were active with the Pope, Barber and Sutherland mills. The land on which these mills operated was reclaimed lakebed constructed from logs and other wood materials rafted from the Apostle islands and the Arrowhead Region of northern Minnesota. By 1901 the ravine was filled with locally available materials to the level of St. Claire Street, although it was still open to the north. Filling continued at that time at the lakefront; much of the western portion of present day Kreher Park was filled and the open sewer was present. The John Schroeder Lumber Company had begun its operations by this date. During this time the sewer network linking the open sewer to the clay tile in the ravine was installed. This timeframe corresponds to the 1902 City of Ashland ordinance forbidding the direct discharge to Chequamegon Bay of manufactured gas plant wastes except via an underground conveyance. Eight years later, by 1909, much of the ravine had been filled, although the bluff face was several feet south of its current location. Later records from 1923 show an expansion of the gas plant with the addition of gas holders and tanks, and expansion of the sawmill and appurtenances at the Schroeder facility. By 1946, Schroeder's facilities remained, but active operations had ceased in the late 1930s. The open sewer was still visible, and the MGP reached its maximum output. By 1951, some of the MGP facilities remained (one holder), although it was no longer operating. A large horizontal tank (propane) was present on the MGP plant site.[10] At the lakefront, the area of the open sewer had been filled, and the Schroeder facilities had been removed. The shoreline had been altered/filled in the area of the former sawmill, and the coal tar dump area was shown on historical maps.

The WWTP was constructed in the early 1950s and began operation in 1953, and was expanded in 1973. During this time, the shoreline east of the WWTP was altered, and additional filling occurred to extend the Prentice Avenue boat launch. The NSPW service center was constructed in the late 1960s. The Ellis Avenue marina was later constructed in 1986. When investigation for a second expansion of the WWTP found contamination in the area of the former coal tar dump in 1989, the project was abandoned. The City later moved operations for the WWTP to another location southeast of the City in 1992.

3.1.4.2 Contaminant Sources and Disposition

During the life of the MGP, releases of NAPL to the environment occurred. Records indicate that a small quantity of this tar material was utilized for fuel or sold, but much was inadvertently lost. The likely routes for discharge of tar is direct discharge of tar into the filled ravine prior to installation of the 12-inch clay tile, and continuing releases to the clay tile pipe network/open sewer when it was functional. It is possible that some of the tar material was entrained in plant wastewater that was discharged to a sewer (e.g., the clay tile). Other tars and NAPL generated as co-product in the gas manufacturing process (such as at holders or releases from fuel tanks) discharged directly to the environment. This material migrated to the base of the ravine, following complete backfilling of the ravine early in the life of the MGP. Other material migrated to the Copper Falls aquifer. Wastewater and other incidental NAPL discharged to the sewer were conveyed via the clay pipe network to the open sewer and then to the bay inlet.

In 1900, Schroeder Lumber began operation at the lakefront. It performed active sawmilling and other lumber operations for more than three decades. The County acquired the lakefront property in 1941; the City then acquired the property from the County in 1942.

Additionally, other industrial sources (such as rail car offloading of feedstocks and raw materials for MGP and other industrial activities) may have caused or contributed to high levels of PAH-rich contaminants at the Lakefront.

[10] This tank and another smaller tank were serviced by underground lines which extended to a railcar loading manifold located at the seep area. These operated during the late 1940s through the 1960s.

In 1947, continued releases of NAPL from the MGP were eliminated with cessation of its operations. However, remnants of NAPL in the ravine continued to migrate via the clay tile to the seep area, discharging to the surface during high flow (storms, etc.) conditions. Since this time, NAPL and the associated groundwater plume in the Copper Falls aquifer continued to migrate north. However, data from these investigations confirm that a potential stagnation or convergence zone in the Copper Falls aquifer in the area of MW-2B(NET) has potentially restricted further movement of the plume to the north (since 2000), the NAPL removal system has removed a fraction (more than 9,700 gallons of product) of the NAPL and dissolved plume mass).

In 1952, the City of Ashland began construction of the WWTP. During the construction, the remnants of the industrial wastes including historic waste from the MGP at the Lakefront were likely discharged to the bay to allow for installation of the new sewer network. The clay core wall was installed to prevent groundwater infiltration into basement areas, and the pipe/sewer distribution network to the new WWTP was constructed. The latter further damaged the earlier pipe network connected to the former open sewer. The distribution of contaminants in sediments along the shoreline was significantly affected by this activity. Other construction actions that occurred after this time that may have further affected contaminant disposition include the WWTP expansion in 1973, and the marina construction in 1986. Since operations at the WWTP were relocated in 1992, no significant contaminant contribution action has occurred.

The residual contamination remaining in the ravine continued to discharge to Kreher Park via the buried tile and fill material. Surface breakthrough was observed following rainfall events. The tile investigation in 2001 crushed and removed much of the tile. The seep remediation in 2001 removed much of the surface contamination at the seep, replaced it with clean fill, and installed EW-4 to capture residual contamination migrating through the seep into the mouth of the ravine. This pathway has been subsequently removed and further migration through the ravine controlled.

The residual contamination at Kreher Park continues to migrate to the lake sediments from the primary NAPL source areas. The contaminants in the fill appear to be in dynamic equilibrium with the sediments. NAPL sources in sediments near the shoreline appear to impact near shore upland areas, as shown by historical monitoring of product levels near the north side of the WWTP (TW-11) and shoreline water quality (PDB) data. These conditions are also demonstrated by vertical gradient measurements between piezometers screened at the base of the fill and water table wells at the shoreline.

3.1.4.3 Summary

The above mentioned CSM corresponds with the historical findings and data developed since investigations began at the Site. The zones of NAPL in the filled ravine and Copper Falls aquifers as well as at the seep occurred through the transport mechanisms described above. Contaminant loading to sediments potentially occurred from the day the MGP began operation initially through direct discharge in ravine and later through clay tile, bluff pipe and open sewer networks. Following filling and abandonment of the sewer system this pathway was eliminated. However, the contaminant loading in the sediments continued through groundwater/NAPL discharge into the lake. Later discharge of residual contamination at Kreher Park by the City via culverts and construction activities occurred prior to and after WWTP construction. The distribution of contaminants in sediments are only explained as multiple discharge points. However, the primary source for the sediment contamination is likely the former MGP. Additionally, the high levels of PAHs in soil at Kreher Park compared to the upper bluff suggest the likelihood of a source at the Lakefront not exclusively caused by MGP waste tars. These other potential sources include spills during rail car off loading of fuel feedstocks and raw materials to support industrial activity, including the former MGP facility and former lumber operations at the lake front.

3.2 Summary of Site Risks

3.2.1 Current and Future Site Use

Current and future uses of the Site include recreational users/visitors, residential (in established residential areas on top of bluff near Xcel Energy office), fishers (both recreational and potentially subsistence), and construction, maintenance and industrial workers. Trespassers are also likely under current conditions in the abandoned WWTP area. Future use of the Kreher Park portion of the Site does not include a residential scenario.

3.2.2 Risks to Human Health

The results of the human health risk assessment (HHRA) for Ashland/NSP Lakefront Superfund Site (Site) in Ashland, Wisconsin (Site) indicate that seven exposure pathways result in estimated risks that exceed U.S. Environmental Protection Agency's (USEPA's) target risk levels(an incremental cancer risk [CR] of 10^{-4} to 10^{-6} and a hazard index [HI] $\leq$ 1) and eight exposure pathways result in estimated risks that are either equivalent to or exceed the Wisconsin Department of Natural Resources' (WDNR's) threshold of (i.e., CR $\leq 1\times10^{-5}$ and HI] $\leq$ 1). These exceedances are indicated below.

Exceeds USEPA Threshold ($CR \geq 1\times10^{-4}$ or $HI > 1$)	Exceeds WDNR Threshold ($CR \geq 1\times10^{-5}$ or $HI > 1$)
Residents (Soil[0-3 feet and all soil depths] - Cancer)	Residents (Soil[0-3 feet and all soil depths] - Cancer)
–	Residential Child (Soil – Noncancer)
Construction Worker (Soil [0-10 feet bgs]/Groundwater)	Construction Worker (Soil [0-10 feet bgs]/Groundwater)
Construction Worker (Trench Air)	Construction Worker (Trench Air)
Adult Swimmer (Surface Water)	Adult Swimmer (Surface Water)
Adult Wader (Surface Water/Oil slicks)	Adult Wader (Surface Water/oil Slicks/Sediment)
Industrial Worker (Indoor Air)	Industrial Worker (Indoor Air)
Subsistence Fisher (Biota)	Subsistence Fisher (Biota)

HI: Hazard index for noncarcinogenic effects

These include estimates for the reasonable maximum exposure (RME) scenarios for potential cancer risks and non-cancer risks. These conclusions are based on assumed exposures to soil in the filled ravine area (for residential receptors) and the filled ravine, upper bluff and Kreher Park area (for construction worker receptors), and to indoor air samples collected at NSPW Service Center. Carcinogenic risks based on central tendency evaluation (CTE) scenarios indicate that only the residential receptor exposure to soil (all soil depths to 10 feet bgs) are estimated to be at a CR of 1×10^{-4}, the upper-end of the USEPA target risk range or greater than the WDNR threshold. Noncarcinogenic risks for the residential receptor (for soil depths 0-1 foot and 0-3 foot bgs) and risks associated with the construction scenario are within acceptable levels. However, residential receptor exposure to subsurface soil is not expected, given the current and potential future land use of the Site. For this Site, residential risks associated with exposures to surface soil (0 to 1 foot bgs) are within the target risk ranges.

Although the results of the HHRA indicate risks for the construction workers under the RME conditions exceed USEPA's target risk levels, the assumptions used to estimate risks to this receptor were conservative and assumed the worst case. Given both the current and future land use of the Site, it is unlikely that construction workers would be exposed to soil in the filled ravine and Upper Bluff. The most likely scenario for the future construction worker is exposure to soil within 0 to 4 feet below ground surface (bgs) at Kreher Park (a typical depth for the installation of underground utility corridors), as most activities associated with the implementation of the future land use would be associated with regrading, landscaping, and road or parking lot construction. Therefore, risks to this receptor population are most likely overstated in this HHRA.

An HI of 3 was calculated for the general industrial worker exposure to indoor air pathway under the RME conditions. This risk level is likely to be an overestimate because:

- It was estimated using the maximum detected concentrations as the concentrations at points of exposure.
- It was calculated based on USEPA default exposure parameters for the industrial /commercial workers (i.e., an individual works at the Site for 8 hours per day, 5 days per week, 50 weeks per year for a total of 25 years). The NSPW Service Center is used as a warehouse; there is an office space inside the building, but used only on a part-time basis.

Cancer risks to subsistence fisher (finfish) are equivalent to the upper-end of the USEPA target risk range, but greater than the WDNR threshold of a CR of 1×10^{-5}. Noncarcinogenic risk is within acceptable limits for both USEPA and WDNR.

Risks to recreational children (surface soil) are equivalent to the WDNR risk threshold. However, risks to adolescent and adult receptors exposed to surface soil are below the USEPA acceptable risk range and below the WDNR risk threshold.

Risks to waders and swimmers (sediments), industrial workers (surface soil), and maintenance workers (surface soil) are all within USEPA's target risk range of 10^{-4} to 10^{-6} for lifetime cancer risk and a target HI of less than or equal to 1 for non-cancer risk and are greater than the WDNR threshold of 1×10^{-5} for lifetime cancer risk and a target HI of less than or equal to 1 for non-cancer risk.

At the request of the Wisconsin Department of Health and family Services (WDHFS), risks were also estimated for construction workers exposed to "oily materials" in groundwater via dermal contact and swimmers and waders who may be exposed to oil slicks in surface water via ingestion and dermal contact. Because no media-specific concentrations are available for either scenario, risks were estimated using analytical data collected from the product stream from the active NAPL recovery system for the Copper Falls aquifer or chemical-specific solubility values detected in the DNAPL sample. Risks to construction workers exposed to "oily material" in groundwater and adult swimmers and waders exposed to "oil slicks" in surface water is greater than both the USEPA upper risk range (CR 1×10^{-4} and HI of 1) and than WDNR threshold (CR 1×10^{-5} and HI of 1). However, it is important to note that there is much uncertainty associated with estimating risks to oily material in groundwater or oil slicks in surface water. The primary uncertainties are associated with the lack of established methodology for estimating this exposure pathway.

3.2.3 Risks to Ecological Receptors

The BERA concluded that the potential for adverse effects to ecological receptors other than benthic macroinvertebrates was not sufficient to result in significant adverse alterations to populations and communities of these ecological receptors. Unacceptable impacts to the benthic macroinvertebrate community in aquatic portions of the Site are possible. Two lines of evidence, bulk sediment chemistry and sediment toxicity testing, indicated that the probability of impairment at the community level was likely.

However, the fact that hydrocarbons are sporadically released as sheens from Site sediment during some high energy meteorological events or when disturbed indicates the potential for impact to the benthic community that may not have necessarily been fully measured by the studies conducted to support the RI. While there is no evidence that effects from these releases will lead to impairment of populations and communities of these receptors inhabiting the waters of Chequamegon Bay, the presence of this continuing source degrades the functioning of a healthy aquatic community in the Site area.

In addition, if normal lakefront activities, i.e., wading, boating etc., were not presently prohibited, the disturbance of sediments and concomitant release of subsurface contaminants of potential concern (COPCs) would increase. This potentially could lead to greater impacts than were measured during these RI/FS studies.

3.3 Calculation of Areal Extent and Volume of Contaminated Media

Based on site investigation results presented in the RI Report, subsurface contamination in the upper bluff area is associated with the former gas holders and located in the filled ravine adjacent to the former MGP building. The filled ravine south of St. Claire Street is currently occupied by the NSPW service center/garage building and an asphalt covered court yard area. However, the filled ravine extends to the north beneath St. Claire Street and a gravel covered NSPW storage yard. The former ravine is filled with material consisting of a mixture of soil, ash, cinders, brick and concrete debris, and minor amounts of glass and metal debris. DNAPL has been encountered in the filled ravine in the vicinity of former gas holders south of St. Claire Street and along the trace of a clay tile encountered at the base of the ravine north of the street. DNAPL has also migrated into the underlying Copper Falls aquifer. The Copper Falls is a confined aquifer underlying the low permeability Miller Creek Formation, which behaves as the confining unit. DNAPL has migrated vertically in this area. The release to the Copper Falls is believed to be located near the former MGP facility where the former ravine dissected this confining unit.

Kreher Park consists of a flat terrace adjacent to the Chequamegon Bay shoreline. The impacted area of Kreher Park occupies approximately 11.5 acres and is bounded by Prentice Avenue and a jetty extension of Prentice Avenue on the east, the Canadian National Railroad on the south, Ellis Avenue and the marina extension of Ellis Avenue on the west, and Chequamegon Bay on the north. The surface elevation of the park varies approximately 10 feet, from 601 feet above MSL, to about 610 feet above MSL at the base of the bluff overlooking the park. The bluff rises to an elevation of about 640 feet above MSL, which corresponds to the approximate elevation of the NSPW property. The lake elevation has historically fluctuated two feet, from 601 to 603 feet above MSL. At the present time, the park area is predominantly grass covered. A gravel overflow parking area for the Ashland Marina occupies the west end of the property; the residual structures of a former miniature golf facility occupy the east end of the site. The City of Ashland former waste water treatment plant (WWTP) and associated structures front the shoreline on the north side of the property. Assuming an average thickness of 12 feet, an estimated 223,000 cubic yards of fill material has been placed between Prentice and Ellis Avenues.

The offshore area with impacted sediments is confined to a small bay created by the Prentice Avenue jetty and marina extensions previously described. The affected sediments consist of lake bottom sand and silts, mixed with and overlain by wood debris that originated from former log rafting lumbering operations. The wood debris layer is up to six feet thick in areas, with an average thickness of nine inches. Wood debris overlays approximately 95% of the impacted sediment. Based on current data, the entire area of impacted sediments encompasses approximately sixteen acres based upon a Preliminary Remediation Goal (PRG) for sediment of 9.5 µg PAH /g @0.415% OC.

The areal extent of soil, groundwater and sediment contamination has been identified based in historic and RI Site Investigation results presented in the RI Report. For the purpose of preparing this document, these results were used to estimate the areal extent of contamination be media. The areal extent of contamination identified for soil, groundwater, and sediment is shown on Figures 3-1, 3-2, and 3-3, respectively. The volume of contaminated media is summarized in Table 3-1, and calculations are included in Appendix D1.

Remedial Action Objectives (RAOs) for the Site, included in Appendix A of the RI Report, can be achieved by containing contaminants on-site, removing highly contaminated source areas, or removing all contaminated media. Potential remedial alternatives evaluated for soil include containment, limited removal of highly contaminated soil, and unlimited removal of all fill soil. Potential remedial responses for sediment include: removal of all sediment to maximum depths of four and ten feet with off-site disposal and/or containment within a CDF, and/or various capping methods. Consequently volume calculations for these potential remedial responses are also shown on Table 3-1, and calculations are included in Appendix D1.

Table 3-1. Volumes and Areal Extent of Contaminated Media

Media	Volume (cubic yards)	Assumptions
Soil		
Upper Bluff Area		
Upper Bluff Area	32,600	Areal extent of contamination at upper bluff where benzene exceeds RCL is approximately 2.02 acres, and thickness is 10 feet. (Includes soil contamination beneath former MGP building).
Filled Ravine Volume	20,700	Areal extent of filled ravine is approximately 1.28 acres, and thickness is 10 feet.
Filled Ravine - Unlimited Removal Volume (Unsaturated and Saturated Zones)		
Filled Ravine	35,000	Areal extent south of alley is approximately 1.09 acres and average depth of 20 feet.
Filled Ravine - Limited Removal Volume (Unsaturated and Saturated Zones		
Former Gas Holder Area	9,400	Areal extent of contamination is 130 by 130 feet, and thickness is 15 feet.
Former Clay Tile Area	150	Areal extent of contamination is 75 by 10 feet, and thickness is 5 feet.
Kreher Park		
Kreher Park	224,600	Areal extent of all fill is approximately 11.6 acres and thickness is 12 feet.

Table 3-1. Volumes and Areal Extent of Contaminated Media		
Media	**Volume (cubic yards)**	**Assumptions**
Unsaturated Zone Soil Volume	83,700	Areal extent of contamination is approximately 10.38 acres, and average thickness is 5 feet.
Saturated Zone Soil Volume	117,200	Areal extent of contamination is approximately 10.38 acres, and average thickness is 7 feet.
Former Coal Tar Dump Area	4,800	Areal extent of contamination is 260 feet by 100 feet (approximately 0.5 acres), and layer is 5 feet thick.
Groundwater		
Upper Bluff Area	65,600	Areal extent of contamination is approximately 2.71 acres, and saturated thickness is 15 feet.
Kreher Park	133,900	Areal extent of contamination is approximately 10.38 acres, and saturated zone is 7 feet.
Copper Falls Aquifer	Upper Bluff 366,700 Kreher Park 133,500 Total 500,200	Areal extent of contamination is 6.9 acres, average thickness of 35 feet beneath Kreher Park, and 50 feet beneath upper bluff area.
Sediment		
Sediment exceeding 10 µg/g[1]	73,800	Approximate areal extent of contamination outside of CDF "footprint" is 10 acres. Estimate includes removal of all wood waste and contaminated sediment in this area.
Sediment exceeding 10 µg/g[1]	78,000	Approximate areal extent of contamination is 16 acres, and includes removal of wood waste and all contaminated sediment to maximum depth of 4 feet.
Sediment exceeding 10 µg/g[1]	133,900	Approximate areal extent of contamination is 16 acres, and includes removal of wood waste and all contaminated sediment to maximum depth of 10 feet.

[1]For purposes of estimating sediment volumes the 9.5 ug PAH/g dwt was rounded to 10 ppm and it was assumed that the concentration was on a dry weight basis.

3.3.1 Soil

Soil contamination was identified at the upper bluff area, primarily in the backfilled ravine, and throughout the Kreher Park fill soil (see Figure 3-1). Benzene was used to conservatively approximate the lateral extent of soil contamination because it has a low clean up standard and is the most frequently occurring VOC constituent in free product waste generated at the former MGP facility. Based on the benzene exceedances of residual contaminant level (RCL) per ch. NR 720, WAC, the areal extent of contamination in the upper bluff area encompasses approximately 2 acres. Assuming an average thickness of 10 feet, this yields 32,600 cubic yards of contaminated soil in the upper bluff area However, as shown in Figure 3-1, soil contamination underlies the NSPW facility buildings (including the former MGP building), parking lots, and St. Clair Street. Approximately 1.28 acres of this 2 acre area is underlain by the filled ravine. Assuming an average thickness of 20 feet, the filled ravine contains an estimated 41,300 cubic yards of fill material.

The filled land at Kreher Park between Prentice and Ellis Avenues occupies approximately 11.6 acres. Assuming a thickness of 12 feet, approximately 224,600 cubic yards of fill material was placed in this former lakebed area to create the existing lakefront area. As with the upper bluff area, benzene was used to conservatively estimate that the lateral extent of soil contamination at the lakefront includes approximately 10.38 acres of Kreher Park. Contaminated soil at Kreher Park underlies a layer of clean fill that ranges in thickness from two feet at the former coal tar dump area to five feet across the remainder of the park. The surface of the park is approximately 5 feet above lake level. Assuming an average thickness of 5 feet, this yields approximately 83,700 cubic yards of unsaturated zone fill soil at Kreher Park. Comparatively, an average thickness of 7 feet yields approximately 117,200 cubic yards of saturated zone fill material.
Potential remedial alternatives for soil evaluated in Section 6.3 focused on the removal of areas with the highest levels of contamination to achieve RAOs. As described in Section 3.1.3 above, these include areas where DNAPL is encountered. At the upper bluff area, this includes an area approximately 130 feet by 130 feet located beneath the central portion of the NSPW service center and adjacent courtyard area; former gas holders for the former MGP were located in this area. Removal south of St. Claire Street will include the excavation of unsaturated and saturated zone soils to a depth between 12 and 15 feet for an area approximately 130 feet by 130 feet, yielding between 7,600 to 9,400 cubic yards. Additionally, removal north of St. Claire Street will include the excavation of saturated zone soil from the bottom five feet of the filled ravine where the clay tile and NAPL were encountered. At the surface, this excavation area will be approximately 30 feet by 75 wide; at the base of the ravine contaminated soil will be removed from a zone 5 to 10 feet wide, 75 feet long, and 5 feet thick. An estimated 75 to 150 cubic yards of NAPL contaminated soil will be removed from the base of the filled ravine.

At Kreher Park, the highest levels of soil contamination encountered above the saturated wood waste layer in the former "coal tar dump area." This area is approximately 260 by 100 feet. Assuming an average depth of 5 feet, there is an estimated 4,800 cubic yards of contaminated soil in this area.

3.3.2 Groundwater

Groundwater contamination was identified in the perched aquifer overlying the Miller Creek formation and in the underlying Copper Falls aquifer. As shown on Figure 3-2, the areal extent of shallow groundwater contamination at the upper bluff area and at Kreher Park is similar to the areal extent of soil contamination (see Figure 3-1.) Compared to shallow groundwater contamination, the areal extent of contamination in the Copper Falls is more extensive at the upper bluff area, but less extensive at Kreher Park. Benzene was used to conservatively approximate the lateral extent of groundwater contamination because it has a low clean up standard and is the most frequently occurring VOC constituent in free product waste generated at the former MGP facility. Based on benzene Enforcement Standard (ES per ch. NR, 140 WAC exceedances), the areal extent of shallow groundwater contamination encompasses almost 3 acres in the upper bluff area and over 10 acres at Kreher Park. The plume in the underlying Copper Falls aquifer is almost 7 acres in size.

Assuming an average thickness of 15 feet, this yields a volume of 65,600 cubic yards of contaminated saturated media (groundwater) in the upper bluff area. Assuming an average thickness of 7 feet, this yields 129,900 cubic yards of contaminated saturated media at Kreher Park. There is an estimated 500,200 cubic yards of contaminated saturated media for the Copper Falls aquifer. This estimate assumes an average plume thickness of 50 feet in the upper bluff area and 35 feet beneath Kreher Park. The actual volume of contaminated groundwater will be less than the volume of saturated media

3.3.3 Sediment

The areal extent of sediment contamination is shown on Figure 3-3. Laboratory results and sample coordinate data for sediment samples were incorporated into geographic information system (GIS). Using ArcGIS, the areal extent of contaminated sediment was first calculated for total PAH concentrations exceeding 10 ppm dry weight (dwt)[11]. Approximately 16 acres of the Site contains total PAH concentrations in excess of 10 ppm. The volume of sediment in the 16 acres was then calculated for contamination up to maximum depths of 4 and 10 feet. Total PAHs exceeding 10 ppm include an estimated 77,800 cubic yards of sediment between 0 and 4 feet, and an estimated 133,900 cubic yards of sediment up to a maximum depth of 10 feet. All volume estimates include wood waste overlying and mixed with the contaminated sediment.

[11] For purposes of estimating sediment volumes the 9.5 ug PAH/g dwt was rounded to 10 ppm and it was assumed that the concentration was on a dry weight basis. The volume of contaminant mass increases as the clean-up standard declines, but the difference between 9.5 and 10 ppm is likely insignificant when estimating volumes for such a large area. In addition the data do not support any greater accuracy in estimating the volume for purposes of FS cost estimates.

4.0 Results of SITE Program Demo/Treatability Studies

4.1 SITE Program Demo

In collaboration with NSPW, EPA conducted a Superfund Innovative Technology Evaluation (SITE) technology demonstration project at the former MGP site. Participants in the demonstration include NSPW, USEPA (Region 5), WDNR, USEPA's Office of Research and Development's National Risk Management Laboratory (NRML) based in Cincinnati, Ohio, and EPA's Technology Innovation and Field Services Division (TIFSD) based in Washington, DC. The technology evaluated is In Situ Chemical Oxidation (ISCO) process using Cool-Ox provided by collaboration between DCI Environmental Remediation Contractors and DeepEarth Technologies, Inc. (DCI/DTI). The field demonstration was completed between November 2006 and February 2007. A report prepared by DCI/DTI describing completed activities and preliminary results is included in Appendix B1.

ISCO is one of the most prevalent technologies currently in use to address deeper subsurface contamination. Despite the extent of use, ISCO has been described by experts as 'developmental' and 'innovative'. A different chemical oxidant has been used at full-scale at least one other former MGP site in Wisconsin, and a pilot-scale project involving activated persulfate was completed at a former MGP in Maryland with promising results. The Cool-Ox®technology is currently undergoing pilot-scale evaluation at a former MGP site in Illinois. Given promising lab and field results using both Cool-Ox® and other ISCO products, EPA's SITE program determined that there was sufficient promise to proceed with the demonstration. Field-scale deployments allow evaluation of the ability of the vendor to deliver active agents to achieve adequate contact with the contaminants.

The Cool-Ox® process relies upon a tailored mixture, an important component of which is an aqueous suspension of solid peroxygen compounds. Theoretically this suspension results in a slow, protracted release of hydrogen peroxide. Through a number of chemical processes, the hydrogen peroxide generates components which attack and destroy VOC and PAH compounds. This process can also result in the generation of oxygen which enhances the biological degradation of the target contaminants.

The SITE Demonstration

USEPA prepared a detailed Quality Assurance Project Plan (QAPP) covering all aspects of the technology demonstration. The SITE demonstration was completed in two areas. These included fill soils in the MW-15 well nest area, where an early gas holder was located, and the deep Copper Falls aquifer at the MW-13 well nest area, where NAPL is being removed via a free-product recovery system.

At the MW-15 area, the demonstration determined that large amounts of free product were present in fill soil placed above the low permeability Miller Creek silty clay within the former holder wall. Field activities included soil sampling before and after injection of Cool-Ox®

reagent into this zone. Sampling analyses indicated that the NAPL was emulsified by the reagent, but that high levels of NAPL within the holder wall minimized increases in microbial populations that could result in bioremediation (injections outside the holder wall where contaminant levels were lower conversely resulted in substantial increases in microbes). Regardless, the NAPL within the holder wall underwent a change in chemical character resulting in a less viscous, miscible material.

The emulsification results at the MW-15 area were also observed at MW-13. Injection of the reagent at this area resulted in vigorous reactions observed at extraction wells. Although the well points were sealed in the Copper Falls aquifer below the Miller Creek formation, bubbling and frothing of the reacted NAPL with the reagent was observed following several injection intervals. Most significantly, the rate of NAPL removal increased nearly four times over a two month period following cessation of the demonstration.

Details of the demonstration and its findings are detailed in the DCI/DTI report (DCI/DTI, August 2007 - Appendix B1).

Free-Product Recovery System – Post SITE Demonstration Findings

Between early February 2007, when the SITE injection program at the MW-13 well nest area ended, and early April 2007, the rate of free-product recovery increased from approximately 1 gal/day to nearly 6 gal/day. For the subsequent eight months, between April and December 2007, the recovery rate slowly declined to its pre-SITE rate of about 1 gal/day. This same period in the decline of the free-product recovery rate saw an increase in the total flows. Although fluctuations in total flow were measured during these eight months (very dry conditions during late summer/early fall corresponded to a decline in flow at that time), a notable flow increase compared to the previous winter months was observed, primarily at EW-4. During the winter of 2007, the EW-4 weekly flows did not exceed 500 gallons; during the following spring through fall period, the weekly flows increased to several thousand gallons.

Beginning in December 2007 through early March 2008, the conditions again reversed. High free-product recoveries were measured compared to lower total flow rates.[12] These conditions are tabulated on Table 4-1 for each of the measurement dates (Summary of Free Product and Groundwater Volumes Removed Since November 2006), and shown graphically on Figures 4-1 (Total Product Removed to Date) and Figure 4-2 (Weekly Pumping Summary). The slope of the total product recovery curve steepens beginning February 2007, then flattens beginning April 2007 through November 2007. It then steepens through March 2008.[13] Comparatively, the weekly pumping summary shows the dramatic increase in the withdrawal at EW-4 beginning in April 2007, corresponding to fluctuations in the flow from this well during the following spring-fall, and then declines in the EW-4 flow December 2007 – March 2008. The weekly pumping curves also show the relatively steady flow from the other extraction wells.

[12] The cumulative flow recovery from EW-1, EW-2 and EW-3, the three extraction wells screened in the Copper Falls Aquifer, generally remains more constant throughout the year compared to the flows measured at EW-4.
[13] Table 4-1 shows a large measurement of free product recovery on March 10, 2008. Product had accumulated at the base of the oil-water separator for several weeks before being conveyed to the storage tank.

This data suggests that the Cool-Ox ISCO process caused a definite improvement in free-product recovery. The injection may have caused changes in free-product chemistry, surfactant effects and increases in formation permeability (via hydraulic fracturing), and/or combinations of these conditions, and enhanced total recovery. The data also implies that increases in flow from EW-4, screened in the filled ravine, tend to "mask" free-product recovery from the Copper Falls aquifer. Consequently, this data will be essential to optimize the design for a future ISCO program and enhanced recovery system if this method is selected for remedial action on the Copper Falls aquifer.

Table 4-1 Summary of Free Product and Groundwater Volume Recovered Since November 2006

Date	Cumulative Volume of Free Product Removed (gals)	Cumulative Volume of Free Product Removed (lbs)	Cumulative Volume of Groundwater Removed from Wells EW-1, EW-2, EW-3 (gals)	Cumulative Volume of Groundwater Removed from well EW-4 (gals)	Cumulative Volume of Total Groundwater Removed (gals)
29-Nov-06	8,273.0	72,447	1,136,723	346,077	1,482,800
06-Dec-06	8,277.1	72,483	1,138,386	346,415	1,484,800
11-Dec-06	8,281.1	72,518	1,140,343	346,657	1,487,000
19-Dec-06	8,285.2	72,554	1,144,773	346,927	1,491,700
27-Dec-06	8,293.4	72,626	1,152,915	347,385	1,500,300
03-Jan-07	8,297.4	72,661	1,158,558	347,742	1,506,300
09-Jan-07	8,301.5	72,696	1,163,598	348,202	1,511,800
18-Jan-07	8,309.7	72,768	1,169,548	348,953	1,518,500
22-Jan-07	8,313.7	72,803	1,173,360	349,240	1,522,600
01-Feb-07	8,321.9	72,875	1,182,142	349,959	1,532,100
08-Feb-07	8,338.2	73,018	1,186,156	350,444	1,536,600
15-Feb-07	8,358.6	73,196	1,191,766	350,834	1,542,600
21-Feb-07	8,370.8	73,303	1,195,200	351,100	1,546,300
01-Mar-07	8,383.0	73,410	1,199,427	351,473	1,550,900
06-Mar-07	8,383.0	73,410	1,202,260	351,640	1,553,900
15-Mar-07	8,440.0	73,909	1,209,660	351,641	1,561,300
22-Mar-07	8,456.3	74,052	1,213,560	351,641	1,565,200
29-Mar-07	8,537.9	74,767	1,227,660	351,641	1,579,300
10-Apr-07	8,562.3	74,980	1,227,433	351,967	1,579,400
17-Apr-07	8,619.4	75,480	1,232,571	367,329	1,599,900
23-Apr-07	8,664.2	75,873	1,229,536	377,664	1,607,200
30-Apr-07	8,709.0	76,265	1,231,877	387,623	1,619,500
09-May-07	8,729.4	76,444	1,236,096	398,904	1,635,000
15-May-07	8,766.1	76,765	1,243,207	403,393	1,646,600
23-May-07	8,843.5	77,443	1,252,542	403,758	1,656,300
30-May-07	8,855.7	77,550	1,257,605	412,795	1,670,400
05-Jun-07	8,880.2	77,764	1,261,410	416,990	1,678,400
11-Jun-07	8,896.5	77,907	1,265,114	419,945	1,685,059
19-Jun-07	8,912.8	78,050	1,267,664	422,336	1,690,000
25-Jun-07	8,933.1	78,227	1,271,172	426,771	1,697,943
05-Jul-07	8,945.4	78,335	1,278,051	430,249	1,708,300
12-Jul-07	8,969.8	78,549	1,281,828	431,673	1,713,501
20-Jul-07	8,982.0	78,656	1,290,577	433,771	1,724,348
16-Aug-07	9,153.2	80,155	1,305,010	437,790	1,742,800
20-Aug-07	9,153.2	80,155	1,307,902	440,198	1,748,100
29-Aug-07	9,165.4	80,262	1,315,407	443,793	1,759,200
05-Sep-07	9,185.8	80,440	1,322,292	445,808	1,768,100
10-Sep-07	9,198.0	80,547	1,327,954	446,946	1,774,900
19-Sep-07	9,202.1	80,583	1,332,189	449,836	1,782,025
26-Sep-07	9,206.2	80,619	1,333,696	457,254	1,790,949

Table 4-1 Summary of Free Product and Groundwater Volume Recovered Since November 2006

Date	Cumulative Volume of Free Product Removed (gals)	Cumulative Volume of Free Product Removed (lbs)	Cumulative Volume of Groundwater Removed from Wells EW-1, EW-2, EW-3 (gals)	Cumulative Volume of Groundwater Removed from well EW-4 (gals)	Cumulative Volume of Total Groundwater Removed (gals)
02-Oct-07	9,210.3	80,655	1,334,914	462,412	1,797,325
12-Oct-07	9,210.3	80,655	1,334,717	462,809	1,797,525
22-Oct-07	9,210.3	80,655	1,331,638	469,763	1,801,400
06-Nov-07	9,222.5	80,762	1,330,449	489,294	1,819,742
12-Nov-07	9,234.7	80,868	1,331,478	495,067	1,826,544
21-Nov-07	9,242.9	80,940	1,334,520	501,132	1,835,651
29-Nov-07	9,246.9	80,975	1,337,816	504,345	1,842,160
06-Dec-07	9,251.0	81,011	1,340,906	506,666	1,847,571
10-Dec-07	9,267.3	81,154	1,342,685	507,837	1,850,521
19-Dec-07	9,283.6	81,297	1,346,224	510,677	1,856,900
27-Dec-07	9,312.1	81,546	1,349,590	512,962	1,862,551
02-Jan-08	9,336.6	81,761	1,352,432	514,171	1,866,602
08-Jan-08	9,365.1	82,010	1,352,568	514,533	1,867,100
18-Jan-08	9,385.5	82,189	1,356,915	518,176	1,875,090
24-Jan-08	9,405.9	82,368	1,359,510	519,289	1,878,798
31-Jan-08	9,409.9	82,403	1,362,684	520,622	1,883,305
07-Feb-08	9,442.5	82,688	1,365,922	521,979	1,887,900
13-Feb-08	9,471.1	82,939	1,367,735	523,266	1,891,000
26-Feb-08	9,475.1	82,974	1,371,204	526,234	1,897,437
07-Mar-08	9,487.4	83,081	1,372,849	527,552	1,900,400
10-Mar-08	9,691.1	84,865	1,373,978	528,514	1,902,491
20-Mar-08	9,691.1	84,865	1,374,132	538,269	1,912,400
28-Mar-08	9,691.1	84,865	1,375,385	542,016	1,917,400
02-Apr-08	9,699.3	84,937	1,380,985	542,016	1,923,000
08-Apr-08	9,703.3	84,972	1,388,850	542,016	1,930,865
14-Apr-08	9,707.4	85,008	1,393,168	542,016	1,935,183
21-Apr-08	9,711.5	85,044	1,409,516	542,021	1,951,537
29-Apr-08	9,715.6	85,080	1,418,809	548,709	1,967,517
07-May-08	9,715.6	85,080	1,495,927	554,298	1,980,224

4.2 Cap Flux Testing

Cap flux testing was conducted to evaluate the potential for transport of PAHs, VOCs, and NAPL in contaminated sediment. The full report, which was submitted to USEPA on August 8, 2007, is included as Appendix B2.

Cap flux testing indicated that transport of PAHs, VOCs, and NAPL can potentially occur via the following processes:

- Migration within pore spaces caused by consolidation under the weight of a cap;
- Diffusion;
- Adsorption to bubbles resulting from microbial metabolism (ebullition); and
- Advection from upward water flow.

Because most of these transport processes are temperature dependent, testing was conducted under conditions similar to those experienced at the Site during the summer as well as under higher than ambient temperatures. These bench scale tests evaluated the effectiveness of various size caps as well as a cap with a carbon mat layer. A report titled *Cap Flux Testing Report* is included as Appendix B2.

The cap flux test evaluated contaminant transport under varying conditions using the following flux columns:

- Accelerated environment without capping – This column was heated to an optimal temperature for bacterial growth (35°C) to simulate the amount of bacterial activity that would typically occur over a longer period of time at in-situ conditions.
- Standard environment without capping - This column was used as a standard to compare performance of capped columns.
- Standard environment with a 1.5 ft sand cap and carbon mat.
- Standard environment with approximately a 3 ft sand cap.
- Standard environment with approximately a 5 ft sand cap.
- Standard environment with a 3 ft cap over a longer period of time - This column test was completed in September 2007; this test and simulates activity over a longer period of time.

Columns used for this test were undisturbed core samples collected from areas of the Site known to have contaminated sediment. A net upward head of 0.01-0.07 feet/foot was placed on all of the test columns to simulate any potential head and transport resulting from the rise and fall of water levels due to seiching.

As part of the testing protocol the following were measured:

1) Consolidation of the sediment columns resulting from the weight of the cap.

2) Contaminants in water and gas that migrated through the columns and caps and were collected at the top of the column.
3) Contaminants and NAPL that migrated through the columns and were adsorbed to glass wool placed at the top of the columns.
4) Contaminants in the top and bottom six inches of the caps as well as in visibly contaminated portions of the sediment core itself.

The results of the flux test indicated that low levels of both VOCs and PAHs were transported through all of the caps and captured in the glass wool. However levels of these constituents passing through the caps were one to two orders of magnitude less than in the uncapped column and two or three orders of magnitude less than in the heated, uncapped column.

Visual evidence shows that NAPL in the form of black drops was transported to the glass wool in the uncapped columns. However, this NAPL was not visible in the glass wool of the capped columns and the presence of substantially lower PAHs and VOCs in the glass wool confirmed that NAPL was not transported into the cap and that significant retention of PAHs and VOCs was achieved during these tests

Only very low levels of the more water-soluble compounds such as of 1- and 2-methylnaphthalene and naphthalene were able to pass though the caps in the dissolved phase under a significantly greater upward flow than is expected at the Site.

Based upon analysis of the sand cap, with one exception, no PAHs or VOCs above 1 mg/kg were transported to even the base of the cap in any column during the testing. The bottom of the cap in the column with a 1.5 ft cap and a carbon mat had 1 mg/kg total PAHs. It is possible that this is an artifact as the duplicate sample from this stratum had 0.632 mg/kg total PAHs.

The absence of contaminants in the gas and in the sand cap indicates that it is likely low levels of contaminants were transported with the water that was used to provide the upward flow gradient. Some contaminants were apparently adsorbed onto the glass wool as they passed through and came into contact with it, the remainder passed through the glass wool and remained in the water.

Overall, results of this cap flux test indicate that even under conditions more favorable to transport than what would be found at the Site, i.e. tests having significant groundwater upwelling, all of the caps were effective in eliminating or substantially reducing the transport of contaminants and NAPL. Based upon the results of this test it is also expected that the presence of organic carbon or some other absorptive material in the capping material would further reduce transport of any contaminants. Additionally, actual temperatures in the Site sediment would be less conducive to bacterial metabolism than the temperatures under which these tests were conducted and as a result gas generation rates would be less.

4.3 Bench Scale Air Emissions Testing

Bench Scale Air Emission testing and dispersion modeling was conducted on selected sediment and soil samples collected from the Site following the USEPA-approved February 2007 Treatability Study Work Plan. The full report, which was submitted to USEPA on September 18, 2007, is appended as Appendix B3.

Sediment samples for this assessment were collected in the part of the Site in Lake Superior at several nearshore locations (Areas 1, 2, and 2A); one soil sample was collected from an upland location (Area 4) (See Appendix B3). Emissions testing on the sediment samples was designed to simulate potential PAH and VOC emission rates associated with dredging operations, sediment dewatering and sediment treatment. Emissions testing conducted on soil from Area 4 was intended to simulate potential PAH and VOC emission rates associated with saturated soil exposure during excavation

Air dispersion modeling based upon the results of the emissions testing was conducted to evaluate how volatilized contaminants would be dispersed under scenarios developed to simulate remedial activities. In particular, modeling was conducted to determine whether receptors outside of the immediate Site area would be exposed to levels of volatile emissions that exceeded risk-based air quality criteria during remedial activities. The USEPA AERMOD model (version 07026) was used for this modeling assessment.

Sediment from each area was homogenized and split into batches to test sediment under three conditions:

1) Exposed sediment;
2) A 10% solids by weight slurry; and
3) A 1% solids by weight slurry.

The slurry mixtures were tested both while being mixed and while quiescent to simulate both active dredging operations and periods of inactivity. Air emissions and sediments were analyzed for 18 VOCs and 27 PAHs. Particular interest was given to benzene, naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene based upon their sediment concentrations and their potential health effects.

Initial analysis found Area 2A to be the most highly contaminated with PAHs and Area 4 to be the most highly contaminated with VOCs. In general, emission rates increased with increasing % of solids and decreased with elapsed time. The highest emission rates were from exposed sediment or mixed 10% solids slurry at the start of the testing runs. Area 2A had the highest overall emission rates.

Odor analysis was conducted on the 10% solids mixed slurry from both Area 2 and 2A to determine the potential for odor impacts resulting from dredging operations. Odor concentrations increased over time, with maximum odor concentrations occurring during the 6-22 hour time interval.

Air dispersion modeling results indicated that, under several of the remedial scenarios, receptors outside the Site work area would be exposed to naphthalene and benzene above health risk levels. The model predicted that under the worst case condition a much larger area outside of the immediate work area would be above the benzene standard than the area where naphthalene standard was exceeded. Results of the modeling, including detailed information on predicted atmospheric concentrations compared to health risk levels are provided in Appendix B3

Similarly, modeling of odor dispersion indicated odor detection units above one odor unit would be experienced beyond the immediate Site work area under some remedial scenarios.

In general, dispersion of volatile contaminants and odor was less for Remedial Alternative 2 (a Confined Disposal Facility) than for Remedial Alternative 3 (Dredge-Cap) or Alternative 4 (Dredge All).

4.4 Multiphase Flow and Consolidation Testing

This report presents the results of the Multiphase Flow and Consolidation Testing, one of several treatability studies recommended in the Candidate Technologies and Testing Needs Technical Memorandum [Treatability Studies Memorandum (Task 6 of the SOW): URS 2006] that was originally submitted to USEPA on September 22, 2006 and approved on February 21, 2007. This test is a type of triaxial test setup known as a Seepage Induced Consolidation (SIC) test. The purpose of this testing is to provide data to be used for evaluating the technical implementability of capping and disposal technologies. The SIC setup was especially designed for very soft sediments to determine multiphase flow and consolidation properties of the sediments at low and medium high stress levels. The full report, which was submitted to USEPA on October 26, 2007, is appended as Appendix B4.

As explained in the introduction to the report, the SIC test works by subjecting a test sample to a constant downward flow rate and measuring the hydraulic pressure differential over the sample. As the stress is applied in this way, the pore fluid is expelled and consolidation occurs resulting in permeability changes within the sediment. These changes can be used to determine the:

1) Compressibility of the sediment;
2) Permeability of the sediment for gas (bubbles), water and non aqueous phase liquids (NAPL);
3) Threshold flow rate necessary to mobilize NAPL;
4) Threshold for air entry into the interstitial spaces which can then be used to evaluate the probability for gas bubble growth (ebullition); and
5) Amount of fluid released upon consolidation.

These characteristics can then be used as inputs to a model (the DELCON model) to predict the behavior of gas, fluid and NAPL in the underlying sediment during capping and during the period that underlying sediments are being consolidated by the cap. The cap can either be one that is applied subaqueously to in-place sediments or a cap applied to sediments after they have been deposited in a confined disposal facility (CDF).

The sediments used for this testing were collected by coring from a representative area of the Site known to be contaminated with polycyclic aromatic hydrocarbons (PAHs), volatile organic carbons (VOCs) and NAPL.

The SIC test was conducted using water, air (nitrogen) and NAPL (diesel fuel) as boundary conditions. Water, air and diesel fuel were forced through the sediment sample in separate tests and various measurements such as pressure, displacement and temperature were made.

A numerical model (DELCON) then was used to simulate the behavior of the sediments under a hypothetical subaqueous or CDF cap. In addition to the data developed in the SIC test supplemental data on the characteristics of Site sediment were used to "populate" the model. Characteristics of Site geology, bathymetry and stratigraphy also were incorporated into the model. Lastly, deposition rates of contaminated material and capping material for various remedial alternatives as well as the properties of sand that will be used as cap material grain (particle) size distribution, minimum and maximum porosity, etc., were provided.

The DELCON model was used to simulate sediment behaviour under two remedial alternatives: dredging and disposal into a CDF (SED 2) and placement of a subaqueous cap (SED 3). Results of the DELCON model indicated:

1) Under the CDF remedial scenario there would be relatively rapid consolidation of the wood layer under the CDF.
2) Only a small amount of consolidation in the Miller Creek clay layer under the wood layer will occur, but that will take place relatively rapidly (within the first five years).
3) Ebullition (gas release) in the underlying wood layer during the consolidation period is possible, however, conditions would no longer favor gas releases after the relatively rapid consolidation of the wood layer and the dredged slurry layer that would take place during the slurry deposition and cap placement time, say 180 days.
4) There would be no NAPL displacement expected from filling the CDF and subsequent consolidation since the predicted pore water discharges through the top layer of the dredged sediment are much smaller than are needed to mobilize NAPL.
5) Settlement consolidation after mechanical dredging under the CDF scenario was predicted to be almost the same as for the hydraulic dredging scenario because of the rapid consolidation of the wood layer beneath the CDF. Assuming the same depth CDF cap, settlement of the mechanically dredged material would be approximately 0.2 ft more than for settlement after hydraulic dredging.
6) Simulation of remedial scenario that includes dredging approximately 4 feet and then placement of a subaqueous cap, indicated that there would be virtually no consolidation of the native sediment given that the level cap re-establishes original bathymetry. Under this remedial scenario the discharges of pore water during capping are not sufficient to mobilize NAPL, nor should the capping result in gas releases substantially greater than what may presently occur.

5.0 Identification of Applicable or Relevant and Appropriate Requirements (ARARs) and To-Be-Considered (TBC) Criteria

5.1 Introduction

Section 121(d) of CERCLA requires that remedial actions undertaken pursuant to CERCLA comply with or otherwise attain legally applicable or relevant and appropriate standards or requirements (ARARs) where such compliance is technically practicable. While not legally binding, consideration is also to be given to TBCs. ARARs and TBCs are the statutes, regulations, ordinances, and guidance, relating to all aspects of the GRAs contemplated in this FS. Remedial alternatives considered in this Technical Memorandum must meet, insofar as practical, the requirements of the ARARs and must consider the interests advanced by the TBCs, including:

- Air, groundwater, surface water quality and residual soil concentration standards,
- Waste handling, storage, transfer and disposal, permitting and siting, requirements and limitations,
- Operating parameters,
- Health and safety requirements, and
- Monitoring requirements.

The identification of ARARs and TBCs depends on the media, COPCs, site-specific characteristics, and the technologies employed during remediation. ARARs are those cleanup standards or controls that are promulgated under state or federal law that specifically address a hazardous substance, pollutant or contaminant, action, location or other situation at a site. A requirement may be "relevant" but may not be "appropriate" to apply for various reasons, and therefore, not well suited for the site. ARARs and TBCs can be chemical-, action- or location-specific requirements. The three types of ARARs are described below.

Chemical-specific ARARs are usually health or risk-based numerical values or methodologies which, when applied to site-specific conditions, define acceptable concentration limits of a chemical that may be found in, remain in, or discharged to, the ambient environment. These standards establish site remediation targets for the COPCs in the designated medium (e.g. water, soil, sediment or air) because those standards are considered protective of human health and the environment. Examples of chemical-specific ARARs include state and federal drinking water quality standards.

Location-specific ARARs are "restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in a specific location." (EPA 1988) Location-specific ARARs place restrictions on remedial activities due primarily to the presence of environmentally sensitive areas. Examples of location-specific ARARs include the standards and requirements imposed for work conducted affecting wetlands.

Action-specific ARARs govern the design, performance, or operational aspects of contaminated materials management. Action-specific requirements "do not themselves determine the cleanup alternative, but define how chosen cleanup alternatives should be achieved" (EPA 1988). Examples of action-specific ARARs include establishment of safe concentrations of discharge of materials during implementation of a remedial action.

ARARs and TBCs that may contribute to defining remedial alternatives for the Ashland/NSP Lakefront Site are presented in Tables E-1 through E-3 in Appendix E. These tables contain detailed information on the relevancy of the ARARs and the TBCs for each potential remedial alternative by environmental media, soil (Table E-1), groundwater (Table E-2) and sediment (Table E-3).

5.2 Chemical-Specific ARARs

Chemical-specific ARARs identified in the Alternatives Tech Memo are as follows:

- Clean Air Act
- Clean Water Act
- Resource Conservation and Recovery Act (RCRA)
- State of Wisconsin Groundwater Quality Standards - WAC Chapter NR 140
- State of Wisconsin Water Quality Standards- WAC Chapter NR 300
- State of Wisconsin Air Quality Standards - WAC Chapter NR 400
- State of Wisconsin Hazardous Substance Spill Law and Soil Cleanup Standards - WAC Chapter NR 700

5.3 Location-Specific ARARs

Location-specific ARARs identified in the Alternatives Tech Memo are as follows:

- Clean Water Act
- Section 10 – Rivers and Harbors Act
- State of Wisconsin - WAC Chapter NR 1.05 and Wisconsin Statute 30.01
- State of Wisconsin Statutes Chapter 289
- State of Wisconsin Solid Waste Management – Beneficial Reuse Exemption WAC Chapter NR 500.08
- State of Wisconsin Statutes Chapter 30

5.4 Action-Specific ARARs

The principal action-specific ARARs that apply to the Ashland/NSP Lakefront Site are as follows.

Action-specific ARARs identified in the Alternatives Tech Memo are as follows:

- Clean Air Act
- Clean Water Act
- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)
- Resource Conservation and Recovery At (RCRA)
- Department of Transportation Rules for Hazardous Materials Transport
- Occupational Safety and Health Administration (OSHA)
- State of Wisconsin Requirements for Plans and Specification Submittal – WAC Chapter NR 108
- State of Wisconsin Environmental Policy Act - Sec. 1.11, Wis. Stats. and WAC Chapter NR 150
- State of Wisconsin Laboratory Certification and Registration Program – WAC Chapter NR 149
- State of Wisconsin Pollutant Discharge Regulations (WPDES) – WAC Chapter NR 200
- State Stormwater Pollution Control Program - WAC Chapter NR 216
- State of Wisconsin Water Quality Regulations – WAC Chapter NR 300
- State of Wisconsin Air Pollution Control Regulations – WAC Chapter NR 400
- State of Wisconsin Solid Waste Management Regulations - WAC Chapters NR 500 through 520
- State of Wisconsin Solid Waste Management Regulations – WAC Chapter NR 500 and Wisconsin Statute 289.43
- State of Wisconsin Hazardous Waste Management Rules – WAC Chapter NR 600
- State of Wisconsin Investigation and Remediation of Environmental Contamination – WAC Chapter NR 700
- State of Wisconsin Statutes Chapter 30

5.5 To Be Considered Information

TBCs can be grouped into chemical-, location-, and action-specific categories. Important laws, regulations and guidance that are TBCs for the Ashland/NSP Lakefront site are listed below. A complete discussion is presented in the Alternatives Tech Memo.

- USEPA's Contaminated Management Strategy
- USEPA's Contaminated Sediment Remediation Guidance
- Agency for Toxic Substances and Disease Registry

- Great Lakes Water Quality Initiative
- State of Wisconsin Interim Consensus Based Sediment Quality Guidance
- WDNR Dredge and Fill Requirements
- Federal Safe Drinking Water Act
- Great Lakes Water Quality Agreement
- Section 303(d) – Clean Water Act
- State of Wisconsin Water Quality Regulations - WAC Chapter NR 300
- WDNR Sediment Quality Assessment at MGP Guidance
- WDNR Management of Waste from Remediation of Manufactured Gas Plants
- WDNR Soil Cover Systems Guidance
- WDNR Soil Cleanup Levels for PAH Guidance
- WDNR Investigation Derived Waste Management Guidance
- WDNR Groundwater Discharge Guidance
- Sediment Remediation Implementation Guidance
- Local Permits

6.0 Development and Evaluation of Remedial Action Alternatives – Soil

6.1 Remedial Action Objectives for Soil

RAOs are subject to the criteria evaluated in the FS. As described in the RAO Technical Memorandum (URS 2007b) preliminary remedial action objectives for soil are as follows:

- Protect human health by reducing or eliminating exposure (ingestion/direct contact/inhalation) to soil having COPCs representing an excess cancer risk greater than 10^{-6} as a point of departure (with cumulative excess cancer risks not exceeding 10^{-5}) and a hazard index (HI) greater than 1 for reasonably anticipated future land use scenarios.
- Ensure future beneficial commercial/industrial use of the Site and recreational use of Kreher Park.
- Protect populations of ecological receptors or individuals of protected species by eliminating exposure (direct contact with or incidental ingestion of soils or prey) to soil with levels of COPCs that would pose an unacceptable risk.
- Conduct NAPL removal whenever it is necessary to halt or contain the discharge of a hazardous substance or to minimize the harmful effects of the discharge to the air, land or water.
- Protect the environment by minimizing/eliminating the migration of contaminants in the soil to groundwater or to surrounding surface water bodies.

The general goal of RAOs is to protect human health and environmental receptors at risk due to the unacceptable concentrations of COPCs at the Site, which are summarized below.

Table 6-1A Remedial Action Objectives for Construction Workers (mg/kg)

Chemical	Carcinogenic Effects			Noncarcinogenic Effects	
	CR = 10^{-6}	CR = 10^{-5}	CR = 10^{-4}	HI = 0.1	HI = 1.0
SVOCs					
2-Methylnaphthalene	NA	NA	NA	1.13E + 02	1.13E + 03
Benzo(a)anthrancene	2.01E + 00	2.01E + 01	2.01E + 02	1.06E + 04	1.06E + 05
Benzo(a)pyrene	2.01E - 01	2.01E + 00	2.01E + 01	NA	NA
Benzo(b)fluoranthene	2.01E + 00	2.01E + 01	2.01E + 02	NA	NA
Dibenzo(a,h)anthracene	2.01E - 01	2.01E + 00	2.01E + 01	NA	NA
Indeno(1,2,2-cd)pyrene	2.01E + 00	2.01E + 01	2.01E + 02	7.06E + 03	7.06E + 04
Naphthalene	NA	NA	NA	3.81E + 00	3.81E + 01
VOCs					
Benzene	1.4E + 00	1.4E + 01	1.4E + 02	4.11E + 00	4.11E + 01

Table 6-1B Soil Remedial Action Objectives for Residents (mg/kg)

Chemical	Carcinogenic Effects		Noncarcinogenic Effects	
	CR = 10^{-5}	CR = 10^{-4}	HI = 0.1	HI = 1.0
SVOCs				
Benzo(a)anthrancene	6.21E + 00	6.21E + 01	NA	NA
Benzo(a)pyrene	6.21E - 01	6.21E + 00	NA	NA
Benzo(b)fluoranthene	6.21E + 00	6.21E + 01	NA	NA
Dibenzo(a,h)anthracene	6.21E - 01	6.21E + 00	NA	NA
Naphthalene	NA	NA	1.70E + 00	1.70E + 01
VOCs				
Benzene	7.37E + 00	7.37E + 01	1.80E + 00	1.80E + 01

6.2 Screening of Remedial Action Alternatives for Soil

6.2.1 Chemicals of Potential Concern – Soil

This evaluation focuses on VOCs and PAHs contained in MGP tar waste as the primary COPCs. NAPL and inorganics associated with the fill soil are also considered in the screening of certain process options for treatment.

6.2.2 Screening of Remedial Alternatives – Soil

Potential remedial alternatives that are capable of preventing direct contact with subsurface soil contamination or reducing the toxicity and mobility of soil contaminants at the upper bluff area and at Kreher Park are summarized in Table 6-2. Those retained in the Alternatives Screening Technical Memorandum (see Appendix A1) are shown in bold in Table 6-2.

Table 6-2 Summary of Soil Technologies Reviewed
(Alternatives in bold are retained)

General Response Action	Remedial Technology	Process Option
No Action	**None**	**Not Applicable**
Institutional Controls	**Physical, engineering or legislative restrictions**	Fencing **Deed restriction** **Legislative action**
Monitored Natural Recovery	**Monitored Natural Attenuation**	Soil monitoring **Groundwater monitoring**
Containment	**Engineered Surface Barrier**	**Installation of ch. NR 500 Clay Cap, Geomembrane, or Geocomposite**
		Existing asphalt pavement and facility buildings (upper bluff area) **Existing soil cover (Kreher Park)**

Table 6-2 Summary of Soil Technologies Reviewed
(Alternatives in bold are retained)

General Response Action	Remedial Technology	Process Option
	Engineered Vertical Barrier	**Sheet piling and/or slurry wall.** Concrete barriers Natural barrier
In-situ Treatment	**Enhanced Bioremediation**	**Oxygen enhancement (air/ozone sparge)** Oxygen enhancement (with chemical oxidation)
	Phytoremediation	Enhanced Rhizosphere Biodegradation Hydraulic Control Phyto-degradation Phyto-volatilization
	Soil Flushing	Cosolvent enhancement Surfactant flooding
	Soil Vapor Extraction (SVE)	Bioventing **Passive SVE** **Active SVE**
	Chemical Oxidation	Ozone sparge **Hydrogen peroxide injection/mixing** **Permanganate injection/mixing**
	Thermal Treatment	Radio Frequency/Electromagnetic Heating **Electrical Resistance Heating** **Steam Injection** Hot Air Injection Vitrification
Removal	**Excavation**	**Limited shallow excavation** **Unlimited shallow excavation** Deep excavation with shoring
Ex-situ Treatment	**Disposal**	**On-site disposal** **Off-site disposal**
	Thermal treatment	Asphalt batch plant mixing **Thermal desorption** **Incineration** Vitrification
	Biological Treatment	Biopile treatment Land spreading
	Solidification /Stabilization	Bituminisation Emulsified asphalt Pozzolan / Portland cement Sludge stabilization
	Physical//Chemical Treatment	**Soil washing** Chemical Oxidation

6.3 Development of Remedial Action Alternatives for Soil

As described in Section 3.3.2, perched aquifer conditions are present above the Miller Creek formation within fill soils at the upper bluff area and at Kreher Park. Saturated fill soil at the upper bluff area is limited to the filled ravine. The thickness of the former "v-shaped" ravine is variable; it is thickest along its axis, but thins perpendicular to its axis. The maximum thickness of fill is approximately 28 feet at the mouth located at the crest of the bluff overlooking Kreher Park, between 15 and 20 feet south of St. Claire Street, and less than 5 feet south of the alley between St Claire and Lakeshore Drive. The water table is encountered within five feet of the ground surface south of St. Claire Street, but at a depth over 10 feet on the north side of the street. The location of the filled ravine is shown on Figure 6-1. (The filled ravine is also shown on Figures 1-2, 1-3, and 3-1.)

Because in-situ treatment cannot be segregated between saturated and unsaturated zone contaminants in the filled ravine, potential in-situ remedial alternatives for soil and shallow groundwater contamination at the upper bluff were evaluated as potential remedial responses for groundwater in Section 7.0. Containment using surface barriers was evaluated as potential remedial responses for soil, and in combination with groundwater remedial responses. Limited and unlimited removal alternatives at the upper bluff include both saturated zone and unsaturated zone soils, and were evaluated as potential soil remediation alternatives because the lateral extent of the filled ravine and contamination within the ravine is well defined. Excavation alternatives include management of shallow groundwater seepage into excavations. Limited removal includes the area within the filled ravine with the highest levels of contamination. This includes removal of areas containing DNAPL, which are shown on Figure 3-4.

Kreher Park also consists of saturated and unsaturated zone fill material overlying the Miller Creek formation. As with the upper bluff area, in-situ treatment cannot be segregated between saturated and unsaturated zone soils. Groundwater is encountered at a shallow depth, and the saturated zone is below lake level. Containment using vertical barriers, and in-situ treatment (for saturated and unsaturated zone soils) were evaluated as potential remedial alternatives for groundwater in Section 7.0. Containment using surface barriers was evaluated as a potential remedial response for unsaturated zone soil, and in combination with potential groundwater remedial responses. For the purpose of evaluating potential remedial alternatives for soil, unlimited removal includes all saturated zone and unsaturated fill material used to construct Kreher Park. Limited removal at the upper bluff area includes removal at DNAPL areas shown on Figure 3-5.

Conceptual designs for potential remedial alternatives for soil retained for screening and evaluated in this report are presented in the following sections, and summarized in Table 6-3.

6.3.1 Alternative S-1 - No Action

The National Contingency Plan (NCP) at Title 40 Code of Federal Regulations (40 CFR §300.430(e)(6)) provides that the no-action alternative should be considered at every site. Implementation of no further action consists of leaving contaminated soil in place; no engineering, maintenance, or monitoring will be required. The "no action" alternative for soil was retained as required by the NCP as a basis for comparing the other alternatives.

6.3.2 Alternative S-2 – Containment Using Engineered Surface Barriers

Surface barriers that would prevent direct contact with subsurface soil contamination include the following:

- Asphalt cap;
- Clay cap;
- Multi-layer cap with a minimum two-foot thick clay barrier, drainage layer, soil and vegetated top soil cover; and,
- Multi-layer cap with geomembrane or equivalent (geocomposite fabric layer or GCL).

The locations of potential surface barriers at the upper bluff and at Kreher Park are shown on Figure 6-2. Key elements of the conceptual design for the use of these engineered surface barriers are as follows:

1. In the upland area the existing building and asphalt pavement will be repaired, upgraded or replaced to improve the integrity of the barriers on the south side of St. Claire Street.
2. New asphalt pavement on the north side of St. Claire Street (NSPW storage yard) and at Kreher Park (marina parking lot) could be installed as surface barriers for these areas to replace existing gravel surfaces.
3. A RCRA class D (i.e., ch. NR 500, WAC) cap will be placed over the former coal tar dump area. This will be an extension of the fine grained low permeability soil cap installed in the adjacent former seep area (following the removal of contaminated soil) as an interim response in 2002.
4. Existing fill soils covering the remainder of Kreher Park are currently preventing contact with subsurface contamination. With respect to soil contamination, capping the remainder of Kreher Park will be unnecessary to prevent direct contact with contaminated soil because no VOC or SVOC contaminants exceed RAOs in fill soils.. However, partial and complete capping options for Kreher Park were evaluated as potential groundwater containment remedial responses in Section 7.0.The former waste water treatment plant is preventing direct contact with the subsurface contamination in that area.[14] In the event that the building is removed, the area will be covered with a clay cap or asphalt pavement to prevent direct contact with subsurface contamination.
5. Surface barriers will be periodically inspected and repaired or replaced as needed to ensure they are performing as designed.

[14] Potential risks associated with the former WWTP were evaluated in detail in the Human Health Risk Assessment. Potential remedial responses for Kreher Park assume that these risks can be mitigated by restoration or redevelopment of the facility in accordance with the City's Waterfront Development Plan.

Surface barriers would not reduce contaminant mass or toxicity of contaminants remaining in place, but they would prevent direct contact with contaminated soil and groundwater. Surface barriers would also reduce infiltration minimizing the potential migration of contaminants from the unsaturated zone to the saturated zone where contaminated soil is present. Consequently, surface barriers were evaluated in combination with remedial responses for soil (described below). Because surface barriers can also be used to reduce groundwater recharge from infiltration, surface barriers as caps were also evaluated in combination with groundwater remedial alternatives described in Section 7.3.

6.3.3 Alternative S-3 - Removal and Off-site Disposal

Removal consists of the excavation of contaminated soil with conventional earth moving equipment. Off-site disposal consists of the transportation of excavated material to an off-site landfill for disposal. Off-site disposal may include the selection of one or more existing landfill facilities for disposal, or alternatively siting and constructing a landfill in the Ashland area in accordance with ch. NR 500, WAC specifically for the disposal of material removed from the Site. Removed material will include contaminated soil from the filled ravine at the upper bluff area, contaminated soil from Kreher Park, and sediment dredged from the offshore inlet area adjacent to the Park. A cost benefit analysis will be needed to evaluate the use of existing landfills, or the construction of a landfill specifically for material removed from the site. Off site disposal facilities will be evaluated in the design phase, and will depend on the cumulative disposal volume of all material from the Site. Both limited and unlimited removal alternatives for contaminated soil from the filled ravine and at Kreher Park were retained for evaluation as potential remedial alternatives.

Following excavation, residual soil and groundwater contamination may remain, which may require natural attenuation and institutional controls for site closure if contaminants remain above RAOs. Direct contact with residual soil and groundwater contamination can be prevented with asphalt pavement or clay caps as surface barriers; using asphalt pavements as a surface barrier was also included to restore site use to pre-remediation conditions.

Alternative S-3A - Limited Removal and Off-site Disposal

Limited removal involves the excavation of material from areas with the highest levels of contamination. At the upper bluff area, this will require the removal of material from the two areas in the filled ravine. The first and largest area is the former gas holder area on the south side of St. Claire Street where NAPL has been encountered. The second and smaller area is at the base of the filled ravine on the north side of St. Claire Street; NAPL was encountered at the base of the ravine at this location in and around a former clay pipe encountered during a 2001 site investigation. The lateral extent of these limited removal excavations are shown on Figure 6-3A. Key elements of the conceptual design for limited removal at the upper bluff area are as follows:

1. Demolition of the center section of the NSPW service center for excavation south of St. Claire Street will be required to access contaminated soil beneath the building at the upper bluff area.
2. Removal of existing asphalt pavement in the alley and courtyard area will also be required.
3. All shallow water table wells screened in the fill soil unit will be abandoned prior to excavation. Piezometers screened in the underlying Copper Falls aquifer will be protected during excavation and backfilling activities and remain in place for future use.
4. Removal will be limited to the excavation of soil containing NAPL, and the removal of buried structures (i.e. former gas holders south of St. Claire Street and the clay tile north of St. Claire Street) at the upper bluff area.
5. Removal south of St. Claire Street will include the excavation of unsaturated and saturated zone soils to a depth between 12 and 15 feet for an area approximately 130 feet by 130 feet, yielding between 7,600 to 9,400 cubic yards.
6. Removal north of St. Claire Street will include the excavation of saturated zone soil from the bottom five feet of the filled ravine where the clay tile and NAPL were encountered. At the surface, this excavation area will be approximately 30 feet by 75 wide. An estimated 75 to 150 cubic yards of NAPL contaminated soil will be removed from the base of the filled ravine.
7. Deep excavations, or excavations completed near facility buildings may require shoring to support sidewalls.
8. Groundwater seeping into the excavation will be collected, temporarily placed in storage tanks, and treated by the existing on-site treatment system prior to discharge to the sanitary sewer.
9. Excavated material will be transported off site for disposal at an existing commercial licensed landfill facility. As an alternative to using existing commercial off-site landfills, a NR500 WAC landfill may be sited on property owned or purchased by NSPW for the disposal of all material removed from the Site.
10. Site restoration will include backfilling excavated areas with clean fill material and installation of new asphalt pavement as a surface barrier over the excavated area south of St. Claire Street to prevent contact with residual soil contamination. On the north side of St. Claire Street, fill soil (overlying NAPL contaminated soil) will be returned to the excavation, and clean soil will be used as to backfill the excavation to grade. Asphalt pavement will be then be placed over the entire gravel covered storage yard as a surface barrier to prevent exposure to fill material left in place on this side of the street. The existing street will be upgraded as needed to provide a surface barrier for this portion of the filled ravine.

At Kreher Park, limited removal will require the excavation of approximately 4,800 cubic yards of contaminated soil overlying the saturated wood waste layer at the former coal tar dump area. The lateral extent of this excavation is also shown on Figure 6-3A. Key elements of the conceptual design for limited removal at Kreher Park are as follows:

1. Site preparation will include clearing and grubbing of small trees and bushes near the south side of the former coal tar dump area.

2. Clean fill soil overlying contaminated soil at the former coal tar area will be removed and used as backfill material following the removal of contaminated soil above the saturated wood waste layer.
3. Removal will include the excavation of unsaturated and saturated zone soils approximately 5 feet thick for an area approximately 260 feet by 100 feet, yielding approximately 4,800 cubic yards.
4. Groundwater seeping into the excavation will be collected, temporarily placed in storage tanks, and treated by the on-site treatment system prior to discharge to the sanitary sewer.
5. Excavated material will be transported off site for disposal at an existing licensed landfill facility, or as an alternative to using an existing off-site landfill, a ch. NR500 landfill may be sited on property owned or purchased by NSPW for the disposal of all material removed from the Site.
6. Site restoration will include backfilling with clean fill material, and installation of a new RCRA or D (NR 500) cap over the excavated area.

With the exception of the former coal tar dump area no RAOs were exceeded in unsaturated zone soil at Kreher Park. Existing fill soils covering the remainder of Kreher Park are currently preventing contact with LNAPL contamination in the underlying saturated wood waste layer. The former waste water treatment plant also prevents contact with subsurface materials. In the event that the building is removed, the area will be covered with a clay cap or asphalt pavement to prevent direct contact. Using surface barriers as caps that prevent infiltration are evaluated as potential groundwater remedial alternatives in Section 7.3.

Alternative S-3B - Unlimited Removal and Off-site Disposal

Unlimited removal will consist of the removal of all fill material and contaminated soil above RAOs. At the upper bluff area, this will require the excavation of all fill material from the filled ravine north from the alley between Lake Shore Drive and St. Claire Street. The lateral extent of the unlimited removal option for the filled ravine is shown on Figure 6-3B. Key elements of the conceptual design for unlimited removal at the upper bluff area are as follows:

1. Demolition of the center section of the NSPW service center for excavation south of St. Claire Street will be required to access contaminated soil beneath the building at the upper bluff area.
2. Removal of existing asphalt pavement in the alley and courtyard area will also be required.
3. Removal and replacement of the section of St. Claire Street overlying the filled ravine (including underground utility realignment) will also be required.
4. Removal will include the excavation of soil containing NAPL, and the removal of all underground structures (i.e. former gas holders) at the upper bluff area. Unlimited removal will include the entire filled ravine north of the alley located between Lake Shore Drive and St. Claire Street to the bluff face. This will include the excavation of approximately 35,000 cubic yards of unsaturated and saturated zone fill material from the filled ravine. This volume includes an estimated 15,000 cubic yards of fly ash material from the area on the north side of St. Claire Street.

5. Deep excavations, or excavations completed near facility buildings may require shoring to support sidewalls.
6. Groundwater seeping into the excavation will be collected, temporarily placed in holding tanks, and treated by the on-site treatment system prior to discharge to the sanitary sewer.
7. Excavated material will be transported off site for disposal at an existing licensed landfill facility. (Fly ash material may be transported to NSPW's fly-ash landfill for disposal.)
8. As an alternative, depending on the available existing landfill capacity, an NR500 landfill may be sited on property owned or purchased by NSPW.
9. Site restoration will include backfilling with clean fill material, replacement of St. Claire Street and utilities, and the installation of new asphalt pavement over excavated areas on the north and south side of St. Claire Street as a surface barrier for any residual soil contamination.

At Kreher Park, this will require the removal of the wood waste layer and overlying fill soil between Prentice and Ellis Avenues. The lateral extent of the excavation area is shown on Figure 6-3B. Key elements of the conceptual design for unlimited removal at Kreher Park are as follows:

1. Site preparation will include clearing and grubbing small trees and bushes near the south side of the former coal tar dump area, and demolition of the former WWTP facility.
2. Clean fill soil overlying the wood waste layer will be removed, salvaged and used to backfill the excavated former ravine at the upper bluff area, or returned to Kreher Park for use as fill material.
3. Removal will include the excavation of the wood waste layer and the overlying fill soil. The estimated volume of fill soil and wood waste material is approximately 223,000 cubic yards.
4. Because the excavation will be completed below lake level, a temporary sheet pile wall will constructed on the north, east, and west sides of the construction area to separate the excavation area from the lake. Approximately 2,000 feet of sheet pile would be installed to a minimum depth of 16 feet below ground surface.
5. Groundwater removed from the saturated portion of the excavation and any seepage into the excavation will be collected and treated by an on-site treatment system prior to discharge to the sanitary sewer[15].
6. Excavated material will be transported off site for disposal at a new landfill facility sited and constructed for the disposal of this material. If possible, wood suitable for fuel at the Bayfront power plant will be salvaged and used for power generation.

Removal of all fill material at Kreher Park could require the construction of an off-site landfill to accommodate the large volume of material removed from the Site. Unlimited removal will result in significant site disturbance, which may result in temporary or permanent loss of the current use of Kreher Park.[16] Kreher Park could be restored to pre-filling conditions (i.e. wetland area or

[15] If sediment removal is selected, on-site treatment equipment from sediment de-watering activities will be utilized for the on-site treatment of groundwater encountered in the unlimited excavation of Kreher Park.
[16] Kreher Park is currently utilized as a recreation area, but it also contains the marina boat storage area, a City street adjacent to the shoreline, and the former waste water treatment building.

shallow lakebed), or backfilled with clean fill to restore it to present elevations. If the area is restored to pre-filling conditions, the sheet pile will be removed. If the excavated area is backfilled to existing grade, the sheet pile wall will remain in place until filled to present grade.

The excavated area could also be backfilled with contaminated sediment dredged from the inlet area, which would require the construction of an onshore confined disposal facility (CDF) for the placement of material removed from the adjacent inlet area. Wisconsin Administration Code Chapter 30 does not prohibit construction of a nearshore CDF and disposal of dredged sediments into a newly constructed CDF. Because contaminated soil will be excavated from the saturated zone encountered below lake level, removal and treatment of contaminated groundwater seeping into the excavation will be required.

6.3.4 Alternative S-4 - Removal and On Site Disposal

Removal will consist of the excavation of contaminated soil with conventional earth moving equipment. On-site disposal consists of the transportation of excavated material to an on-site landfill for disposal. Residual soil and groundwater contamination may remain above RAOs, which may require natural attenuation and institutional controls for site closure if contaminants remain above RAOs. Inadequate space is available for on-site disposal at the upper bluff area, but adequate space is available at Kreher Park for the construction of an on-site disposal cell. The on-site disposal cell at Kreher Park could accommodate all or a portion of the material removed from the filled ravine at the upper bluff area previously described for Alternatives S-3A (limited removal) and S-3B (unlimited removal). It could also accommodate the limited removal of contaminated soil from the former coal tar dump area. Additionally, on-site disposal could accommodate the disposal of dredged sediment from the inlet area. On-site disposal would need to be completed in combination with containment alternatives for shallow groundwater at Kreher Park described in Section 7.3, and/or in conjunction with sediment containment alternatives described in Section 8.3. Key elements of the conceptual design for limited and unlimited removal of material from the filled ravine at the upper bluff and limited removal of contaminated soil from the former coal tar dump area are described in Section 6.3.3 above.

Alternative S-4A includes limited removal and on-site disposal of material from the upper bluff and the former coal tar dump area. Between seven and nine feet of contaminated soil could be placed in a one acre disposal cell constructed at Kreher Park between Prentice Avenue and the former coal tar dump area. Alternative S-4B includes a larger disposal cell required for unlimited removal material at the upper bluff area. This would require placement of approximately six feet of contaminated soil in a disposal cell four acres in size. Alternative S-4A is shown on Figure 6-4A, and Alternative S-4B is shown on Figure 6-4B. The conceptual design for the construction of an on-site disposal facility at Kreher Park follows:

1. Site preparation will include clearing and grubbing of small trees and bushes near the south side of the former coal tar dump area.

2. A disposal cell for material excavated from the upper bluff area will be constructed at Kreher Park. Contaminated soil from the former coal tar dump area will also be placed in this disposal cell.
3. The disposal cell will include a liner and a cap The size and location of the disposal cell will depend on the volume of material removed from the filled ravine
4. Clean fill soil overlying the wood waste layer at Kreher Park will be removed for the construction of the disposal cell and used to backfill excavated areas. Fill soil outside the foot print of this area will be left in place.
5. Any groundwater seeping into the disposal cell during construction will be collected, temporarily placed in holding tanks, and treated by an on-site treatment system prior to discharge to the sanitary sewer[17].
6. Site restoration at the upper bluff will include backfilling with salvaged clean fill material and installation of a RCRA cap or new asphalt pavement over the excavated area south of St. Claire Street, the existing street, and the gravel covered courtyard area on the north side of the street. A RCRA class D (ch. NR 500) cap will then be placed over the backfilled former coal tar dump area.
7. Long-term operation and maintenance for the disposal cell will include the groundwater monitoring and periodic inspection and repair of all asphalt and soil caps.

This soil remedial alternative could be combined with containment alternatives evaluated for groundwater and sediment in Sections 7.3 and 8.3, respectively. If excavated soil and sediment are mixed, a larger disposal cell will be required.[18] The design of the liner and cap should be compatible with the groundwater remedial response selected for shallow groundwater at Kreher Park. The thickness of the disposal cell liner could be reduced if containment is selected as the final remedial response.

6.3.5 Alternative S-5 – Ex-situ Thermal Treatment

Thermal treatment physically separates volatile and some semi-volatile contaminants from excavated soil or sediment by using ambient air, heat, and/or mechanical agitation to volatilize contaminants from soil into a gas stream for further treatment. Thermal treatment is achieved by either low temperature thermal desorption (LTTD), high temperature thermal desorption (HTTD), or incineration. The type of thermal treatment selected will be based on RAOs for VOCs and PAHs in treated soil. Another consideration is the suitability of treated soil as backfill material; soil treated by LTTD will retain pre-treatment physical properties (i.e. organic content) whereas soil treated by HTTD and incineration will not. Soils thermally treated on site can be returned to the excavation as backfill. Clean fill will be needed to replace soils transported off site for treatment and disposal.

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[17] If sediment removal is selected, on-site treatment equipment from sediment de-watering activities may also be utilized for the on-site treatment of groundwater seeping into the excavation during construction.

[18] A larger disposal cell would be needed for on-site disposal of sediment in an on-site confined disposal facility (CDF). The on-site disposal of an additional 134,000 cubic yards of sediment would require a CDF 8 acres in size with a waste thickness of approximately 13 feet. The on-site disposal of an additional 78,000 cubic yards of sediment would require a CDF 6 acres in size with a waste thickness of approximately 12 feet.

LTTD is highly effective for VOCs; PAH compounds can also be treated, but at a reduced effectiveness. HTTD is effective for PAH compounds, but is not as cost effective as LTTD for VOCs. Incineration is effective for both VOCs and PAH compounds, but treating contaminated soil at high temperatures (1,400 to 2,200 ºF) to volatilize and combust organic compounds would require significantly more effort than LTTD or HTTD. An on-site mobile incinerator would operate in a similar fashion as HTTD except the kiln would be direct-fired[19] and would cause some COPCs to be destroyed before the vapors reach the secondary combustion chamber. In addition, the gas flow rates are higher in an incinerator since the fuel and air combustion gases are included in the gases sent from the kiln to the secondary combustion chamber. Additional soil tests such as sieve analysis, soil fusion temperature, and soil heating value are generally needed to achieve proper incineration. Although mobile incinerators are available, most incineration is achieved at off-site facilities due to the substantial amount of equipment involved. Transportation costs, energy costs to sustain high temperatures, and regulatory compliance for incineration would be significantly higher than LTTD and HTTD costs. For this analysis we have assumed that on-site treatment will be completed by LTTD or HTTD, and that incineration will be completed at an off-site facility.

Alternative S-5A - Limited Removal and On-site Thermal Treatment

On-site thermal treatment will require excavation of contaminated material at the upper bluff area as previously described for the limited removal alternatives described above (Alternatives S-3A and S-4). Excavated soil could be transported off site, but most likely would be treated on site by a mobile unit. Debris must be separated by size from material suitable for thermal treatment and transported off site for disposal. Consequently, wood waste at Kreher Park[20] and fly-ash and cinders in the filled ravine at the upper bluff area must be separated from NAPL contaminated material encountered in these areas. Thermal treatment by LTTD or HTTD will be completed for suitable NAPL contaminated fill material, and contaminated material not suitable for thermal treatment will be transported off site for disposal. Fill material including fly ash and cinders that is not contaminated with VOC and PAH compounds will be returned to the excavation. Residual soil and groundwater contamination may remain, which may require natural attenuation and institutional controls for site closure if residual contaminants remain above RAOs.

Thermal treatment will be performed on suitable fill material from areas with the highest levels of contamination. This includes the former gas holder area at the upper bluff, the NAPL in the ravine and contaminated soil encountered above the wood waste layer at Kreher Park; the underlying wood waste layer would not be suitable for thermal treatment. The lateral extent of these excavations are shown on Figure 6-1. Key elements of the conceptual design for ex-situ thermal treatment of material removed from these areas follows:

[19] Medium and high temperature thermal desorption may also be direct-fired, but at a lower temperature than incineration.

[20] Some wood waste may be present at the former coal tar dump area.

1. A mobile unit and ancillary equipment will be set up at Kreher Park because inadequate space is available at the upper bluff area.
2. Demolition of the center section of the NSPW service center for excavation south of St. Claire Street will be required to access contaminated soil beneath this building at the upper bluff area.
3. Removal of existing asphalt pavement in the alley and courtyard area will also be required.
4. All shallow water table wells screened in the fill soil unit will be abandoned prior to excavation. Piezometers screened in the underlying Copper Falls aquifer will be protected during excavation and backfilling activities and remain in place for future use.
5. Removal will include the excavation of soil containing NAPL, and the removal of buried structures (i.e. former gas holders) at the upper bluff area south of St. Claire Street. This area includes the excavation of unsaturated and saturated zone soils to a depth between 12 and 15 feet for an area approximately 130 feet by 130 feet, yielding between 7,600 and 9,400 cubic yards. Also included for removal will be soil containing NAPL in the ravine on the north side of St. Claire Street. This will include the excavation of saturated zone soil from the bottom five feet of the filled ravine where the clay tile and NAPL were encountered. At the surface, this excavation area will be approximately 30 feet by 75 wide. An estimated 75 to 150 cubic yards of NAPL contaminated soil will be removed from the base of the filled ravine.
6. Removal will also include the excavation of unsaturated and saturated zone soils at the former coal tar dump area. This includes approximately 5 feet of contaminated soil in an area approximately 260 feet by 100 feet, yielding approximately 4,800 cubic yards.
7. Deep excavations, or excavations completed near facility buildings may require shoring to support sidewalls.
8. Groundwater seeping into the excavation will be collected, temporarily placed in holding tanks, and treated by the on-site treatment system prior to discharge to the sanitary sewer.
9. Saturated and unsaturated zone material will be thermally treated to reduce contaminant mass and toxicity and returned to the excavation as back fill. Material unsuitable for thermal treatment will be transported off site for landfill disposal. Fill material not contaminated with VOC and PAH compounds will be returned to the excavation as backfill.
10. Site restoration at the upper bluff area will include the installation of new asphalt pavement as a surface barrier over the excavated area on both sides of St. Claire Street, and new asphalt pavement at the gravel covered courtyard area on the north side of the street. The existing street (inspected for water tightness and sealed or replaced as needed) and new asphalt pavement on the NSPW property will prevent exposure to fill material beneath St. Claire Street and the NSPW storage yard.
11. Site restoration at Kreher Park will include backfilling excavated areas with clean fill material and installation of a new RCRA Class D (ch. NR 500) cap over the excavated area.
12. Long-term operation and maintenance of backfilled areas will include groundwater monitoring, cap maintenance including the periodic inspection and repair of all asphalt and soil caps.

Alternative S-5B - Limited Removal and Off-site Incineration

Incineration will require excavation of contaminated material at the upper bluff area and the former coal tar dump area at Kreher Park as previously described for the other limited removal alternatives (Alternatives S-3A, S-4, and S-5A). Contaminated soil suitable for incineration would be transported off site to a licensed facility for treatment and disposal. Wood waste at Kreher Park and fly-ash and cinders in the filled ravine at the upper bluff area must be separated from contaminated soil selected for incineration. Debris will be separated by size from material suitable for incineration and transported off site for disposal, and fill material not contaminated with VOCs and PAHs will be returned to the excavation as backfill.

As with thermal treatment, incineration will be performed on suitable fill material from areas with the highest levels of contamination. This includes the former gas holder area at the upper bluff, the NAPL in the ravine and contaminated soil encountered above the wood waste layer at Kreher Park. The lateral extent of these excavations are shown on Figure 6-1. Key elements of the conceptual design for ex-situ thermal treatment of material removed from these areas follows:

1. All contaminated material will be separated from debris and transported off site for incineration and/or off-site disposal. Ancillary equipment needed to separate material suitable for incineration will be set up at Kreher Park because inadequate space is available at the upper bluff area.
2. Demolition of the center section of the NSPW service center for excavation south of St. Claire Street will be required to access contaminated soil beneath the building at the upper bluff area.
3. Removal of existing asphalt pavement in the alley and courtyard area will also be required.
4. All shallow water table wells screened in the fill soil unit will be abandoned prior to excavation. Piezometers screened in the underlying Copper Falls aquifer will be protected during excavation and backfilling activities and remain in place for future use.
5. Removal will include the excavation of soil containing NAPL, and the removal of buried structures (i.e. former gas holders) at the upper bluff area south of St. Claire Street. This area includes the excavation of unsaturated and saturated zone soils to a depth between 12 and 15 feet for an area approximately 130 feet by 130 feet, yielding between 7,600 and 9,400 cubic yards. Also included for removal will be soil containing NAPL in the ravine on the north side of St. Claire Street. This will include the excavation of saturated zone soil from the bottom five feet of the filled ravine where the clay tile and NAPL were encountered. At the surface, this excavation area will be approximately 30 feet by 75 wide. An estimated 75 to 150 cubic yards of NAPL contaminated soil will be removed from the base of the filled ravine.
6. Removal will also include the excavation of unsaturated and saturated zone soils at the former coal tar dump area. This includes approximately 5 feet of contaminated soil in an area approximately 260 feet by 100 feet, yielding approximately 4,800 cubic yards.
7. Deep excavations, or excavations completed near facility buildings may require shoring to support sidewalls.

8. Groundwater seeping into the excavation will be collected, temporarily placed in holding tanks, and treated by the existing on-site treatment system prior to discharge to the sanitary sewer.
9. Saturated and unsaturated zone material will be transported off site for incineration and subsequent off-site disposal. Material unsuitable for incineration will be transported off site for landfill disposal. Fill material not contaminated with VOC and PAH compounds will be returned to the excavation as backfill.
10. Site restoration will include backfilling the excavation with clean fill material and installation of new asphalt pavement as a surface barrier over the excavated area south of St. Claire Street to prevent contact with residual soil contamination. On the north side of St. Claire Street, fill soil (overlying NAPL contaminated soil) will be returned to the excavation, and clean soil will be used as to backfill the excavation to grade. Asphalt pavement will be then be placed over the entire gravel covered storage yard as a surface barrier to prevent exposure to fill material left in place on this side of the street. The existing street will be upgraded, as needed, to provide a surface barrier for this portion of the filled ravine.
11. Long-term operation and maintenance of backfilled areas will include groundwater monitoring, cap maintenance including the periodic inspection and repair of all asphalt caps.

6.3.6 Alternative S-6 – Limited Removal and On-site Soil Washing

Soil washing is a water-based process for mechanically scrubbing excavated soil to remove contaminants by dissolving or suspending them in the wash solution. Contaminated soil from the saturated and unsaturated zones will be treated by soil washing following removal by excavation. Contaminants are either removed by dissolving or suspending them in a wash solution, or reducing concentrations in smaller volumes of soil by gravity separation. Wastewater used for soil washing is treated on site prior to discharge. A bio-slurry reactor is a hybrid soil washing technique that is used to treat a slurry of wastewater and contaminated soil. An aqueous slurry is created by combining soil, sediment, or sludge with water and other additives. The slurry is mixed to keep solids suspended and microorganisms in contact with the soil contaminants. Upon completion of the process, the slurry is dewatered and the treated soil is disposed or returned to the excavation. Material processing equipment (mixing unit and batch tanks) and water treatment equipment will require room for setup near one of the excavation areas. A mobile unit will be used to treat (wash) soil on site. Treated soil will be returned to the excavation as backfill material. Semi-volatile organics and hydrophobic contaminants may require the addition of a surfactant or organic solvent. A bench or pilot-scale treatability test may be needed to determine the best operating conditions and wash fluid compositions for soil washing and or bio-slurry treatment.

On-site soil washing can also be applied to contaminated material in the upper bluff area, and limited areas at Kreher Park, as described for the limited removal alternatives previously described (Alternatives S-3A, S-4, S-5A, and S-5B). Man-made fill material (i.e. ashes, cinders, bricks, concrete, wood debris, and glass) is not suitable for soil washing and will require separation and off-site disposal. The presence of wood waste at Kreher Park and fly-ash and cinders in the filled ravine (on the north side of St. Claire Street in the upper bluff area) will preclude the use of soil washing of debris from these areas. Consequently, soil washing will be used for contaminated fill soil removed from areas with high concentrations of VOCs and PAH compounds at Kreher Park and the upper bluff area. Residual soil and groundwater contamination may remain, which may require natural attenuation and institutional controls for site closure if contaminants remain above RAOs.

Limited removal and on-site soil washing will be limited to areas with the highest levels of contamination. This includes the former gas holder at the upper bluff area where NAPL has been encountered, and the former coal tar dump area at Kreher Park. The lateral extent of these excavations are shown on Figure 6-1. Key elements of the conceptual design for limited removal and ex-situ soil washing in the upper bluff area and Kreher Park are as follows:

1. Soil washing and ancillary equipment will be set up at Kreher Park because inadequate space is available at the upper bluff area.
2. Demolition of the center section of the NSPW service center for excavation south of St. Claire Street will be required to access contaminated soil beneath the building at the upper bluff area.
3. Removal of existing asphalt pavement from the alley and courtyard area will also be required.
4. All shallow water table wells screened in the fill soil unit will be abandoned prior to excavation. Piezometers screened in the underlying Copper Falls aquifer will be protected during excavation and backfilling activities and remain in place for future use.
5. Removal will include the excavation of soil containing NAPL, and the removal of buried structures (i.e. former gas holders) at the upper bluff area south of St. Claire Street. This area includes the excavation of unsaturated and saturated zone soils to a depth between 12 and 15 feet for an area approximately 130 feet by 130 feet, yielding between 7,600 and 9,400 cubic yards. Also included for removal will be soil containing NAPL in the ravine on the north side of St. Claire Street. This will include the excavation of saturated zone soil from the bottom five feet of the filled ravine where the clay tile and NAPL were encountered. At the surface, this excavation area will be approximately 30 feet by 75 wide. An estimated 75 to 150 cubic yards of NAPL contaminated soil will be removed from the base of the filled ravine.
6. Removal will also include the excavation of unsaturated and saturated zone soils at the former coal tar dump area. This includes approximately 5 feet of contaminated soil in an area approximately 260 feet by 100 feet, yielding approximately 4,800 cubic yards.
7. Deep excavations, or excavations completed near facility buildings may require shoring to support sidewalls.
8. Groundwater seeping into the excavation will be collected, temporarily placed in holding tanks, and treated by the on-site treatment system prior to discharge to the sanitary sewer.
9. Saturated and unsaturated zone material will be treated by soil washing to reduce contaminant mass and toxicity, and returned to the excavation as back fill. Material unsuitable for soil washing will be transported off site for landfill disposal.
10. Site restoration will include the installation of new asphalt pavement as a surface barrier over the excavated area south of St. Claire Street, and new asphalt pavement at the gravel covered courtyard area on the north side of the street. The existing street (inspected for

water tightness and sealed or replaced as needed) and new asphalt pavement on the NSPW property will prevent exposure to fill material beneath St. Claire Street and the NSPW storage yard.

11. Site restoration at Kreher Park will include backfilling with clean fill material, and installation of a new RCRA Class C or D cap or asphalt road or parking lot over the Kreher Park area.
12. Long-term operation and maintenance for the site will include groundwater monitoring and periodic inspection and repair of all asphalt caps.

Table 6-3 - Summary of Potential Remedial Alternatives for Soil

Soil Remediation	Alternative S-1 No Action	Alternative S-2 Containment using Engineered Surface Barriers	Alternative S-3A Limited Removal and Off-site Disposal	Alternative S-3B* Unlimited Removal and Off-site Disposal	Alternative S-4A/S-4B Limited / Unlimited (from upper bluff) Removal and On-site Disposal	Alternative S-5A Limited Removal and On-site Thermal Treatment	Alternative S-5B Limited Removal and Off-site Incineration	Alternative S-6 Limited Removal and On-site Soil Washing
Removal /Treatment Volume (cubic yards)								
Upper Bluff Area	0	35,000	7,675 to 9,550	35,000	7,675 to 35,000	7,675 to 9,550	7,675 to 9,550	7,675 to 9,550
Kreher Park	0	4,800	4,800	224,600	4,800	4,800	4,800	4,800
Removal /Treatment Method								
Upper Bluff Area	None	No treatment prior to capping.	No treatment prior to disposal.	No treatment prior to disposal.	No treatment prior to disposal.	On-site thermal treatment staged at Kreher Park.	Off-site incineration and disposal.	On-site soil washing staged at Kreher Park
Kreher Park	None							
Disposal Required								
Upper Bluff Area	No removal or treatment of contaminated soil.	No removal or treatment of contaminated soil.	Transport all material to off-site ch. NR 500 permitted landfill for disposal, or site and construct new nearby off-site landfill per ch. NR 500 requirements for disposal of all material removed from the Site.		Site and construct new disposal cell at Kreher Park for disposal of all excavated material.*	Transport debris not suitable for treatment to an off-site NR 500 landfill for disposal.	Transport debris not suitable for treatment to an off-site NR 500 landfill for disposal.	Transport debris not suitable for treatment to an off-site NR 500 landfill for disposal.
Kreher Park								
Excavation Dewatering Required								
Upper Bluff Area	No	No	Yes – utilize on- site treatment system.	Yes – utilize on-site treatment system.*	Yes – utilize on-site treatment system.*	Yes – utilize on-site treatment system.*	Yes – utilize on-site treatment system.*	Yes – utilize on-site treatment system.*
Kreher Park								
Backfill								
Upper Bluff Area	None	None	Clean fill from off-site source.	Clean fill from Kreher Park.	Clean fill from Kreher Park.	Return treated soil to excavation, and fill to grade with clean fill from an off-site source.	Clean fill from off-site location.	Return treated soil to excavation, and fill to grade with clean fill from an off-site source.
Kreher Park				Clean fill from off-site location as needed.				
Site Restoration								
Upper Bluff Area	None	Asphalt pavement over former ravine.	Asphalt pavement over former ravine.	Asphalt pavement over former ravine.	Asphalt pavement over former ravine.	Asphalt pavement over former ravine.	Asphalt pavement over former ravine.	Asphalt pavement over former ravine.
Kreher Park		Cap over former coal tar dump area.	Cap over former coal tar dump excavation area.	Restore Kreher Park to pre-removal elevations with	Cap over former coal tar dump excavation area and disposal cell.	Cap over former coal tar dump excavation area.	Cap over former coal tar dump excavation area.	Cap over former coal tar dump excavation area

Table 6-3 - Summary of Potential Remedial Alternatives for Soil

Soil Remediation	Alternative S-1 No Action	Alternative S-2 Containment using Engineered Surface Barriers	Alternative S-3A Limited Removal and Off-site Disposal	Alternative S-3B* Unlimited Removal and Off-site Disposal	Alternative S-4A/S-4B Limited / Unlimited (from upper bluff) Removal and On-site Disposal	Alternative S-5A Limited Removal and On-site Thermal Treatment	Alternative S-5B Limited Removal and Off-site Incineration	Alternative S-6 Limited Removal and On-site Soil Washing
				clean fill or restoration as wetland or shallow lakebed.				
Other Remedial Technologies Used								
Upper Bluff Area	MNA Instit. Cntrls. Surface Barriers Vertical Barriers	MNA Instit. Cntrls Vertical Barriers	MNA Instit. Cntrls Surface Barriers Vertical Barriers	MNA Institutional Cntrls	MNA Instit. Cntrls Surface Barriers Vertical Barriers CDF	MNA Instit. Cntrls Surface Barriers Vertical Barriers	MNA Instit. Cntrls Surface Barriers Vertical Barriers	MNA Instit. Cntrls Surface Barriers Vertical Barriers
Kreher Park				MNR Vertical Barriers				

* Disposal cell could be enlarged for on-site disposal of sediment.
** May include use of sediment de-watering treatment equipment if sediment removal is selected for off-shore contamination.

6.4 Detailed Analysis of Remedial Alternatives for Soil

Potential remedial alternatives for soil were evaluated in this section in accordance with the threshold criteria, primary balancing criteria, and modifying criteria described in Section 6.4.1 below.

6.4.1 Threshold Criteria

Threshold criteria, which relate to statutory requirements that each alternative must satisfy to be eligible for selection, include:

- Overall protection of human health and the environment; and
- Compliance with ARARs.

The "no action" alternative will not satisfy threshold criteria; it will not result in the protection of human health and the environment. The remaining potential remedial alternatives for soil (removal and off-site disposal and removal and ex-situ treatment) will result in a reduction in mass, toxicity, or mobility of contaminants, which will result in the overall protection of human health and the environment.

The "no action" alternative will not achieve compliance with ARARs. However, the remaining potential remedial alternatives for soil will achieve compliance with ARARs, which are summarized in Table E-1 in Appendix E. Remedial responses for soil were screened in the Alternative Screening Technical Memorandum, and responses that were retained for screening were further evaluated in this report. Remedial responses that would not protect human health and the environment or achieve compliance with ARARs were not retained for screening.

6.4.2 Balancing Criteria

The primary *balancing criteria*, which are the technical criteria upon which the detailed analysis is primarily based, include:

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost.

A summary of the balancing criteria for each potential remedial alternative for soil follows.

6.4.2.1 Long Term Effectiveness and Permanence

Each remedial alternative is evaluated as to magnitude of long-term residual risks, adequacy of controls, and reliability of long-term management controls in restoring soil contamination. Table 6-4 presents an evaluation of the long-term effectiveness and permanence of each alternative.

Table 6-4 - Evaluation of Long-term Effectiveness and Permanence For Potential Soil Remedial Alternatives

Alternative	Magnitude and Type of Residual Risk	Adequacy and Reliability of Controls
Alternative S-1 No Action	• Potential risk to human health or the environment would not be reduced.	• There are no remedial actions or controls associated with this alternative.
Alternative S-2 Containment using Engineering Surface Barriers	• Contaminants will remain in soil beneath a surface barrier that will prevent direct contact. • Surface barriers will also reduce infiltration and minimize leaching to groundwater.	• Surface barriers will effectively prevent direct contact with contaminated soil and reduce infiltration. • Reliability is high through maintenance of barriers and institutional controls; these can easily be implemented. • Most effective if used in conjunction with a remedial response for groundwater.
Alternative S-3A Limited Removal and Off-site Disposal	• Limited removal of source areas containing NAPL and elevated concentrations of VOCs and PAHs will minimize residual soil contamination. • Other contaminants (i.e. metals) and groundwater contamination may remain. • Site restoration will include surface barriers to prevent direct contact with subsurface residual contamination and reduce infiltration to minimize leaching to groundwater.	• Removal of shallow soil from filled ravine and former coal tar dump area with conventional earth moving equipment is highly reliable. • Removal of source areas containing NAPL and elevated concentrations of VOCs and PAH compounds would sufficiently reduce risk to human health and the environment. • Surface barrier maintenance will be required to maximize reliability of remedial response. Institutional controls could be easily implemented to prevent long-term exposure to residual subsurface contamination.
Alternative S-3B Unlimited Removal and Off-site Disposal	• This remedial response will results in the removal of contaminated and un-contaminated fill material. • Unlimited removal of all fill material will minimize potential for residual contamination. • Construction of an off-site landfill would likely be required for large volume of material.	• Removal of shallow soil from filled ravine with conventional earth moving equipment is highly reliable, but would require removal and replacement of buried utilities and section of city streets, which may be difficult to implement. • Significant contamination is present at base of fill at Kreher Park, but removal of fill material below lake level will be difficult to implement. • Kreher Park restoration may require placement of clean fill, or restoration of former lakebed as wetland area or shallow lakebed.

Table 6-4 - Evaluation of Long-term Effectiveness and Permanence For Potential Soil Remedial Alternatives

Alternative	Magnitude and Type of Residual Risk	Adequacy and Reliability of Controls
Alternative S-4A Limited Removal and On-site Disposal	• Limited removal of source areas containing NAPL and elevated concentrations of VOCs and PAHs will minimize residual soil contamination. • Site restoration will include surface barriers over excavated area and over disposal cell to prevent direct contact with subsurface residual contamination and reduce infiltration to minimize leaching to groundwater. • Groundwater monitoring will likely be needed to evaluate on-going risk to human health and the environment	• Removal of shallow soil from filled ravine with conventional earth moving equipment is highly reliable. • Removal of source areas containing NAPL and elevated concentrations of VOCs and PAH compounds would sufficiently reduce risk to human health and the environment. • Surface barrier maintenance will be required to maximize reliability of remedial response. Institutional controls could be easily implemented to prevent long-term exposure to residual subsurface contamination.
Alternative S-4B Limited Removal and On-site Disposal	• This remedial response will results in the removal of contaminated and un-contaminated fill material. • Unlimited removal of all fill material will minimize potential for residual contamination. • Construction of an on-site landfill would likely be required for large volume of material.	• Removal of shallow soil from filled ravine with conventional earth moving equipment is highly reliable, but would require removal and replacement of buried utilities and section of city streets, which may be difficult to implement. • Kreher Park is the only area where there is adequate space for the on site construction of a disposal cell. • Construction of a disposal cell at Kreher Park may limit future site use of this area.
Alternative S-5A Limited Removal and On-site Thermal Treatment ***Alternative S-5B*** Limited Removal and Off-site Incineration	• Limited removal of source areas containing NAPL and elevated concentrations of VOCs and PAHs will minimize residual soil contamination. • Other contaminants (i.e. metals) and groundwater contamination may remain. • Site restoration will include surface barriers over excavated area and over disposal cell to prevent direct contact with subsurface residual contamination and reduce infiltration to minimize leaching to groundwater. • Groundwater monitoring will likely be needed to evaluate on-going risk to human health and the environment	• Removal of shallow soil from filled ravine and former coal tar dump area with conventional earth moving equipment is highly reliable. • Thermal treatment/incineration is reliable technology. • Although other contaminants may remain, removal of source areas containing NAPL and elevated concentrations of VOCs and PAH compounds would significantly reduce risk to human health and the environment. • Minimal long-term maintenance and monitoring will be required to evaluate reliability. Institutional controls could be easily implemented to prevent long-term exposure to residual subsurface contamination and treated material placed as backfill, and contaminated material placed in disposal cell.

Table 6-4 - Evaluation of Long-term Effectiveness and Permanence For Potential Soil Remedial Alternatives

Alternative	Magnitude and Type of Residual Risk	Adequacy and Reliability of Controls
Alternative S-6 Limited Removal and On-site Soil Washing	• Limited removal of source areas containing NAPL and elevated concentrations of VOCs and PAHs will minimize residual soil contamination. • Other contaminants (i.e. metals) and groundwater contamination may remain. • Site restoration for limited removal will include surface barriers to prevent long-term exposure to subsurface residual contamination and reduce infiltration to minimize leaching to groundwater. • Groundwater monitoring will likely be needed to evaluate on-going risk to human health and the environment	• Removal of shallow soil from filled ravine and former coal tar dump area with conventional earth moving equipment is highly reliable, but residual contamination may remain in treated soil. • Long-term monitoring will be required following on-site placement of treated soil to evaluate reliability. • Minimal long-term surface barrier maintenance and monitoring will be required to evaluate reliability of remedial response. Institutional controls could be easily implemented to prevent long-term exposure to residual subsurface contamination and treated material placed as backfill.

6.4.2.2 Reduction of Toxicity, Mobility or Volume through Treatment

The remedial alternatives are evaluated for permanence and completeness of the remedial action in significantly reducing the toxicity, mobility, or volume of hazardous materials through treatment. Each alternative is evaluated based on the treatment processes used, the volume or amount and degree to which it destroys or treats hazardous materials; the expected reduction in toxicity, mobility, or volume provided by the alternative; the extent to which the treatment is irreversible; and the types and quantities of residuals that will remain following treatment. Table 6-5 presents a summary of this evaluation.

Table 6-5 - Evaluation of Reduction of Toxicity, Mobility, or Volume through Treatment For Potential Soil Remedial Alternatives

Alternative	Treatment Process Used and Materials Treated	Volume of Material Removed, Destroyed or Treated	Degree of Expected Reductions	Degree to Which Treatment is Irreversible	Type and Quantity of Residuals Remaining
Alternative S-1 No Action	None	None	None	Not applicable	Not applicable
Alternative S-2 Containment using Engineering Surface Barriers	No material treated; engineered surface barriers used to prevent direct contact.	None	No reduction in contaminant mass or toxicity, but will reduce infiltration and minimize mobility of contaminants leaching to groundwater.	Surface barriers could easily be removed.	Contaminated soil will remain in place beneath surface barriers placed over the filled ravine and former coal tar dump areas; the wood waste layer at Kreher Park will remain in place.
Alternative S-3A Limited Removal and Off-Site Disposal	No treatment prior to disposal at off-site landfill.	7,675 to 9,650 cubic yards removed from upper bluff area, and 4,800 cubic yards removed from the former coal tar dump area.	Removal of highly contaminated fill where NAPL is present will result in significant reduction of contaminant mass. Reduction of toxicity, mobility and volume reduction is expected to be high.	Off-site disposal would be irreversible.	Residual contamination may remain in the filled ravine and former coal tar dump area; the wood waste layer at Kreher Park will remain in place.
Alternative S-3B Unlimited Removal and Off-site Disposal	No treatment prior to disposal at off-site landfill.	35,100 cubic yards removed from the upper bluff area and 224,600 cubic yards removed from Kreher Park.	Removal of all fill material containing high and low levels of contamination will result in significant reduction of contaminant mass. Reduction of toxicity, mobility and volume reduction is expected to be very high.	Off-site disposal would be irreversible.	All fill soil containing high and low levels of contamination removed. The wood waste layer at Kreher Park will be removed. Little to no residual soil contamination would be expected.

Table 6-5 - Evaluation of Reduction of Toxicity, Mobility, or Volume through Treatment For Potential Soil Remedial Alternatives

Alternative	Treatment Process Used and Materials Treated	Volume of Material Removed, Destroyed or Treated	Degree of Expected Reductions	Degree to Which Treatment is Irreversible	Type and Quantity of Residuals Remaining
Alternative S-4A Limited Removal and On-site Disposal	No treatment prior to disposal at on-site disposal cell.	7,675 to 9,650 cubic yards removed from the upper bluff area. Nothing removed from Kreher Park, and 4,800 cubic yards removed from the former coal tar dump area.	Removal of highly contaminated fill will result in significant reduction of contaminant mass. Reduction of toxicity and mobility is expected to be high for the filled ravine. Although contaminated soil will be contained, on-site disposal will not result in reduction of volume of material. .	Material placed in disposal cell at Kreher Park would remain in place, or transported off-site at a later time.	Residual contamination may remain in fill at upper bluff area; the wood waste layer at Kreher Park will remain in place.
Alternative S-4B Unlimited Removal and On-site Disposal		35,100 cubic yards from the upper bluff consolidated with 4,800 cubic yards removed from the former coal tar dump area.			
Alternative S-5A Limited Removal and On- site Thermal Treatment	On-site thermal treatment to remove contaminants. Return treated soil to excavation.	7,675 to 9,650 cubic yards removed from upper bluff area, and 4,000 cubic yards removed from the former coal tar dump area.	Removal and thermal treatment of highly contaminated fill where NAPL is present will result in significant reduction of contaminant mass. Reduction of toxicity, mobility and volume is expected to be high.	Thermal treatment would be irreversible; treated soil would remain in place as back fill, or transported off site at a later time.	Residual contamination may remain in untreated fill at the upper bluff and at the former coal tar dump area; the wood waste layer at Kreher Park would remain in place.
Alternative S-5B Limited Removal and Off- site Incineration	Off-site incineration to treat contaminated soil. Clean fill used to back fill excavated areas.			Incineration would be irreversible.	

Table 6-5 - Evaluation of Reduction of Toxicity, Mobility, or Volume through Treatment For Potential Soil Remedial Alternatives

Alternative	Treatment Process Used and Materials Treated	Volume of Material Removed, Destroyed or Treated	Degree of Expected Reductions	Degree to Which Treatment is Irreversible	Type and Quantity of Residuals Remaining
Alternative S-6 Limited Removal and On-site Soil Washing	Soil washing to remove contaminants. Return treated soil to excavation.	7,675 to 9,650 cubic yards removed from upper bluff area, and 4,000 cubic yards removed from the former coal tar dump area.	Removal of highly contaminated fill will result in significant reduction of contaminant mass. Reduction of toxicity, mobility and volume reduction is expected to be high.	Soil washing would be irreversible; treated soil would remain in place as back fill, or transported off site at a later time.	Residual contamination may remain in untreated fill at the upper bluff and at the former coal tar dump area; the wood waste layer at Kreher Park would remain in place.

6.4.2.3 Short Term Effectiveness

The evaluation of short-term effectiveness is based on the degree of protectiveness of human health achieved during construction and implementation of the remedy. Potential implementation risks to the community and site workers and mitigation measures for addressing those risks are included in this evaluation. In addition, environmental impacts during implementation and the time required to achieve the RAOs must also be considered in the evaluation of this criterion. Table 6-6 summarizes the results of this evaluation.

Table 6-6 - Evaluation of Short Term Effectiveness for Potential Soil Remedial Alternatives

Alternative	Protection of Community and Workers During Remediation	Environmental Impacts of Remedy	Time Until RAOs are Achieved
Alternative S-1 No Action	None	No additional impact to the environment	RAOs will not be achieved.
Alternative S-2 Containment using Engineering Surface Barriers	Actions to protect community during remediation will include restricted access to work areas to prevent direct contact, and perimeters monitoring to ensure airborne contaminants are not migrating from the work area. Action to protect site workers during remediation will include the use of earth moving equipment to handle contaminated soil in exclusion zones, personnel protection equipment for workers, and work zone monitoring for airborne contaminants.	Surface barrier will reduce infiltration and minimize leaching to groundwater, but long-term source for groundwater contamination will remain.	Direct contact exposure route can be eliminated in a short time frame, but contaminants will remain beneath surface barrier for an extended period of time.
Alternative S-3A Limited Removal and Off-site Disposal		Significant contaminant mass will be removed from highly contaminated areas where DNAPL is present. Residual contaminants may remain on site.	Site work can be completed in a short time frame. Post remediation monitoring for residual contamination remaining on site may be needed to ensure compliance with RAOs.
Alternative S-3B Unlimited Removal and Off-site Disposal		All fill material including contaminated and uncontaminated material will be removed from fill ravine and at upper bluff and Kreher Park; minimal residual contamination may remain.	Site work can be completed in a short time frame, and verification soil samples collected following removal of all material will be used to determine compliance with RAOs.
Alternative S-4A Limited Removal and On-site Disposal		Significant contaminant mass will be removed from highly contaminated areas where DNAPL is present. Residual contaminants may remain on site.	Site work can be completed in a short time frame, and verification soil samples collected following removal of all material will be used to determine compliance with RAOs. Long term monitoring will be required to ensure disposal cell compliance with RAOs.
Alternative S-4B Unlimited Removal and On-site Disposal		All fill material including contaminated and uncontaminated material will be removed from fill ravine and at upper bluff and coal tar dump area at Kreher Park; minimal residual contamination may remain in excavated areas.	Site work can be completed in a short time frame, and verification soil samples collected following removal of all material will be used to determine compliance with RAOs.

Table 6-6 - Evaluation of Short Term Effectiveness for Potential Soil Remedial Alternatives

Alternative	Protection of Community and Workers During Remediation	Environmental Impacts of Remedy	Time Until RAOs are Achieved
Alternative S-5A Limited Removal and On-site Thermal Treatment	Actions to protect community during remediation will include restricted access to work areas to prevent direct contact, and perimeters monitoring to ensure airborne contaminants are not migrating from the work area. Action to protect site workers during remediation will include the use of earth moving equipment to handle contaminated soil in exclusion zones, personnel protection equipment for workers, and work zone monitoring for airborne contaminants.	Significant contaminant mass will be removed from highly contaminated areas where DNAPL is present. Residual contaminants may remain on site.	Site work can be completed in short time frame. Post remediation monitoring for residual contamination remaining on site may be needed to ensure compliance with RAOs. Long-term monitoring may be needed for areas backfilled with treated soil.
Alternative S-5B Limited Removal and Off-site Incineration			Site work can be completed in a short time frame, and verification soil samples collected following removal of all material will be used to determine compliance with RAOs.
Alternative S-6 Limited Removal and onsite Soil Washing		Significant contaminant mass will be removed from highly contaminated areas where DNAPL is present. Residual contaminants may remain on site.	Site work can be completed in short time frame. Post remediation monitoring for residual contamination remaining on site may be needed to ensure compliance with RAOs. Long-term monitoring may be needed for areas backfilled with treated soil.

6.4.2.4 Implementability

Implementability is based on the evaluation of technical feasibility, administrative feasibility, and the availability of services and materials. Technical feasibility considers the following factors:

- difficulties that may be inherent during construction and operation of the remedy;
- the reliability of the remedial processes involved;
- the flexibility to take additional remedial actions, if needed;
- the ability to monitor the effectiveness of the remedy;
- the availability of offsite treatment, storage, and disposal facilities; and,
- the availability of needed equipment and specialists.

Administrative feasibility considers permitting and regulatory approval and coordination with other agencies. Table 6-7 presents a summary of this evaluation.

Table 6-7. Evaluation of Implementability for Potential Soil Remedial Alternatives

Alternative	Technical Feasibility	Reliability of Technology	Administrative Feasibility	Availability of Services and Materials
Alternative S-1 No Action	Additional remedial actions could be easily implemented.	Not applicable.	No permitting required, but will likely not be able to obtain regulatory approval.	None required.
Alternative S-2 Containment using Engineering Surface Barriers	Installation is technically feasible for areas where fill and/or subsurface contamination are present. Additional remedial actions could be easily implemented.	Reliable technology for elimination of direct contact exposure route and reduction of infiltration.	Regulatory approval likely if implemented with remedial response for shallow groundwater contamination.	Conventional construction equipment could be used for construction of surface barriers.
Alternative S-3A Limited Removal and Off-site Disposal	Excavation is feasible technology for remediation of contaminated soil. Likely that removal and off-site disposal of all fill soil containing NAPL and high VOC and PAH concentrations will result in a significant reduction of contaminant mass.	Highly reliable technology; most commonly used remedial technology for contaminated soil at MGP sites.	Regulatory approval likely. Selection of landfill for off-site disposal would be required.	Conventional earth moving and excavation de-watering equipment would be used. Groundwater would be treated on site with existing equipment.
Alternative S-3B Unlimited Removal and Off-site Disposal	Removal of all fill material from filled ravine is feasible, but excavation of saturated fill at Kreher Park below lake level may be difficult. A landfill may need to be sited and constructed for disposal of the large volume of contaminated soil.	Reliable technology; most commonly used for contaminated soil at MGP sites. However, removal of all fill material may not be needed to achieve compliance with RAOs.	Regulatory approval likely. Would require siting and construction of landfill for off-site disposal, and approval of restoration of Kreher Park to either pre-filling (i.e. wetland, or shallow lake bottom), or pre-removal conditions.	Conventional earth moving and excavation de-watering equipment would be used. Groundwater would be treated on site using equipment used for sediment remediation.

Table 6-7. Evaluation of Implementability for Potential Soil Remedial Alternatives

Alternative	Technical Feasibility	Reliability of Technology	Administrative Feasibility	Availability of Services and Materials
Alternative S-4A and S-4B Limited Removal and On-site Disposal	Disposal cell construction at Kreher Park is technically feasible. Long-term maintenance and monitoring of disposal cell will likely be completed in combination with containment of Kreher Park using surface and vertical barriers walls (evaluated as a groundwater remedial alternative).	Reliable technology, but not commonly used for contaminated soil at MGP sites due to land-use limitations.	Regulatory approval likely. Would require siting and construction of disposal cell for on-site disposal.	Conventional earth moving, equipment and excavation de-watering equipment will be used. Groundwater will be treated on site with existing equipment.
Alternative S-5A Limited Removal and On-site Thermal Treatment	On-site thermal treatment is a feasible technology for remediation of contaminated soil at MGP sites. Likely that removal and on-site thermal treatment of all fill soil containing NAPL and high VOC and PAH concentrations will result in a significant reduction of contaminant mass.	Highly reliable technology; it is commonly used for contaminated soil at MGP sites. Would require separation and off-site disposal of debris not suitable for thermal treatment.	Regulatory approval likely. Discharge permits for air and waste water may be needed.	Conventional earth moving, thermal treatment and excavation de-watering equipment would be used. Groundwater would be treated on site with existing equipment.
Alternative S-5B Limited Removal and Off-site Incineration	Off-site incineration is technically feasible, but will be more costly than on-site thermal treatment. Likely that removal and off-site incineration of all fill soil containing NAPL and high VOC and PAH concentrations will result in a significant reduction of contaminant mass .	Highly reliable technology; but incineration may not be needed to achieve RAOs. Would require separation and off-site disposal of debris not suitable for incineration.	Regulatory approval likely. Selection of facility for off-site incineration would be required.	Incineration most commonly performed at off-site facilities due to specially equipment and required air permits.

Table 6-7. Evaluation of Implementability for Potential Soil Remedial Alternatives

Alternative	Technical Feasibility	Reliability of Technology	Administrative Feasibility	Availability of Services and Materials
Alternative S-6 Limited Removal and onsite Soil Washing	Pilot test would be needed to evaluate reliability of soil washing. Likely that removal of all fill soil containing NAPL and high VOC and PAH concentrations will result in a significant reduction of contaminant mass	Pilot test will need to be completed to evaluate reliability of technology; technology not commonly used for contaminated soil at MGP sites.	Regulatory approval likely. Discharge permits for air and waste water may be needed.	Conventional earth moving, soil washing and excavation de-watering equipment would be used. Groundwater would be treated on site with existing equipment.

6.4.2.5 Cost

Preliminary estimated costs for potential soil remedial alternatives include estimated capital costs for site preparation, excavation, excavation de-watering, transportation and disposal, on-site treatment, and site restoration. Estimated costs for mobilization/demobilization, engineering, construction oversight, and contingency costs are estimated at 5, 15, 15, and 20-percent of capital costs, respectively. Annual operation, maintenance, and monitoring (OM&M) costs are not estimated for each alternative; it is assumed the OM&M following soil remediation will be completed concurrent with OM&M following groundwater remediation. Consequently, OM&M costs are included with potential groundwater remedial alternatives costs in Section 7.5.7. Additionally it is assumed that all work is contracted and the estimates do not account for possible economies of scale (i.e., completing all activities at the site concurrently). These cost estimates are developed primarily for the purpose of comparing remedial alternatives and not for establishing project budgets. Detailed cost estimates were prepared in accordance with the USEPA guidance document, *A Guide to Developing and Documenting Cost Estimates* (USEPA and USACE, 2000). Table 6-8 presents a summary of the cost evaluation. The details of these costs are presented in Appendix F1 Tables F1-1 through F1-10

Table 6-8. Evaluation of Cost for Potential Soil Remedial Alternatives

Alternative	Area of Concern	Capital Cost	Mob/Demob	Engineering	Construction Oversight	Contingency	Post Construction Maintenance[1]	Total
Alternative S-1 No Action	Upper Bluff/ Kreher Park	$0	$0	$0	$0	$0	$0	$0
Alternative S-2 Containment Using Engineered Surface Barriers	Upper Bluff	$105,556	$5,278	$15,833	$15,833	$21,111	$21,716	$163,611
	Kreher Park	$1,118,563	$55,928	$167,784	$167,784	$223,713		$1,755,488
Alternative S-3A Limited Removal and Off-site Disposal	Upper Bluff	$2,203,435	$110,172	$330,515	$330,515	$440,687	$0	$3,415,324
	Kreher Park	$973,848	$48,692	$146,077	$146,077	$194,770	$0	$1,509,464
Alternative S-3B Unlimited Removal and Off-site Disposal (backfill to existing grade)	Upper Bluff	$5,103,860	$255,193	$765,579	$765,579	$1,020,772	$0	$7,910,983
	Kreher Park	$22,591,722	$1,129,586	$3,388,758	$3,388,758	$4,518,344	$0	$35,017,169
Alternative S-3B Unlimited Removal and Off-site Disposal (restore Kreher Park as wetland)	Upper Bluff	$1,451,850	$72,593	$217,778	$290,370	$290,370	$0	$2,250,368
	Kreher Park	$1,054,203,	$52,710	$158,130	$210,841	$210,841	$0	
Alternative S-4A Limited Removal and On-site Disposal [2]	Upper Bluff	$1,451,850	$72,593	$217,778	$217,778	$290,370	$0	$2,250,368
	Kreher Park	$1,054,203	$52,710	$158,130	$158,130	$210,841	$0	$1,634,014
Alternative S-4B Unlimited Removal and On-site Disposal [3]	Upper Bluff	$1,788,580	$89,429	$268,287	$268,287	$357,716	$0	$2,772,299
	Kreher Park	$2,364,788	$118,239	$354,718	$354,718	$472,958	$0	$3,665,421
Alternative S-5A Limited Removal and Ex-situ Thermal Treatment	Upper Bluff	$3,036,291	$151,815	$455,444	$455,444	$607,258	$0	$4,706,250
	Kreher Park	$1,392,456	$69,623	$208,868	$208,868	$278,491	$0	$2,158,306
Alternative S-5B Limited Removal and Off-site Incineration	Upper Bluff	$5,228,016	$261,401	$784,202	$784,202	$1,045,603	$0	$8,103,424
	Kreher Park	$2,436,468	$121,823	$365,470	$365,470	$487,294	$0	$3,776,525
Alternative S-6 Limited Removal and Ex-situ Soil Washing	Kreher Park	$3,671,748	$183,587	$550,762	$550,762	$734,350	$0	$5,691,209
	Kreher Park	$1,711,848	$85,592	$256,777	$256,777	$342,370	$0	$2,653,364

1 Does not include groundwater monitoring costs, which are included with groundwater remedial alternatives.
2 Includes construction of a one acre disposal cell at Kreher Park.
3 Includes only construction of a four acre disposal cell at Kreher Park.

6.4.3 Modifying Criteria

The third group, the *modifying criteria*, includes:

- State/Support agency acceptance
- Community acceptance.

As previously discussed, these last two criteria are typically formally evaluated following the public comment period, although they can be factored into the identification of the preferred alternative to the extent practicable. With regard to community acceptance criterion, it should be noted that the agencies conducted an outreach session consisting of a "community workshop" in Ashland on October 25, 2007. A summary of that workshop as presented by USEPA is included in Appendix C.

6.5 Comparative Analysis of Retained Remedial Alternatives for Soil

In this section, as required by CERCLA and NCP regulations, the alternatives will undergo a comparative evaluation wherein the advantages and disadvantages of the alternatives will be concurrently assessed with respect to each criterion. The criteria considered as part of this comparative evaluation are defined in detail in the Comparative Alternatives Analysis tech memo and summarized in the Executive Summary of this report. Table 6-9 presents a summary of the comparative analysis.

Table 6-9 – Comparison of Potential Soil Remedial Alternatives

Criteria	Alt. S-1	Alt. S-2	Alt. S-3A	Alt. S-3B	Alt. S-4A	Alt. S-4B	Alt. S-5A	Alt. S-5B	Alt. S-6
	No Action	Containment using Engineered Surface Barriers	Limited Removal and Off-site Disposal	Unlimited Removal and Off-site Disposal	Limited Removal (from upper bluff) and On-site Disposal	Unlimited Removal (from upper bluff) and On-site Disposal	Limited Removal and On-site Thermal Treatment	Limited Removal and Off-site Incineration	Limited Removal and Ex-situ Soil Washing
Overall Protection of Human Health and the Environment	None	Low	High	High	Moderate	High	High	High	Moderate to High
Compliance with ARARs and TBCs	None	Low	High	High	Low to Moderate	Low to Moderate	High	High	Moderate to High
Long-term Effectiveness and Permanence	None	Low	High	High	Low to Moderate	Low to Moderate	High	High	Moderate to High
Reduction of Toxicity, Mobility and Volume through Treatment	None	Low	High	High	Low to Moderate	Low to Moderate	High	High	Moderate to High
Short-term Effectiveness	Low	High	High	High	Moderate	Moderate	High	High	High
Implementability	None	High	High	Low to Moderate	High	High	High	Low to Moderate	Moderate
Cost	Low	Low	Moderate	Very High	Moderate	Moderate	High	Very High	High
Agency Acceptance	None	Low	High	High	Low to Moderate	Low	High	High	Low to Moderate
Community Acceptance	None	Low	High	Low to Moderate	Low	Low	Moderate	High	Low to Moderate

6.5.1 Overall Protection of Human Health and the Environment

Alternative S-1 (no action) offers no additional protection for human health and the environment because no additional actions would be taken to address soil contamination at the Site. ***Alternative S-3B*** (unlimited removal and off-site disposal) offers the highest level of protection of human health and the environment in the long-term because all fill and contaminated soil would be removed. ***Alternative S-3A*** (limited removal and off-site disposal), ***Alternative S-5A*** (limited removal and on-site thermal treatment), and ***Alternative S-5B*** (limited removal and incineration) would also offer high levels of protection because these remedial responses would result in the removal of a significant contaminant mass. ***Alternative S-6*** (limited removal and treatment by soil washing) would offer moderate to high level of overall protection of if this technology can be implemented to effectively reduce contaminant concentrations. ***Alternative S-2*** (containment using engineered surface barriers) will eliminate the direct contact exposure route, but will provide a low level of overall protection because soil contamination will remain. ***Alternatives S-4A*** and ***S-4B*** (limited and unlimited removal and on-site disposal) will provide a moderate level of human health and the environment because highly contaminated material from the upper bluff area and the former coal tar dump area will be consolidated into a disposal cell at Kreher Park.

Although unlimited removal for ***Alternative S-3B*** (unlimited removal and off-site disposal) will provide high level of human health and environmental protection, limited removal for Alternatives S-3A, S-5A, S-5B, and S-6 will also provide adequate protection because these remedial responses will result in the removal of a significant mass of contamination. Although Alternatives S-2 and S-4 will result in the containment of contaminated materials, which will be inaccessible to humans or biota, thereby reducing risk, the overall level of protection are lower because there is no reduction on contaminant mass.

6.5.2 Compliance with ARARs and TBCs

Alternative S-1 (no action) will not achieve compliance with ARARs and TBCs. Implementation will require that engineering and construction actions be developed and completed in compliance with federal and state regulations. ***Alternatives S-2, S-4A,*** and ***S-4B*** (surface barriers, and limited and unlimited removal and on-site disposal) must be implemented with a groundwater remedial response to achieve compliance. If properly implemented, the remaining remedial responses could achieve compliance with ARARs and TBCs for soil.

6.5.3 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence considers long-term residual risks, adequacy of controls, and reliability of long-term management controls in restoring soil contamination. ***Alternative S-1*** (no action) will not provide any long-term benefit; no additional actions will be taken to address soil contamination at the Site. ***Alternative S-3B*** (unlimited removal and off-site disposal) will provide the highest effectiveness and permanence over the long term because all contaminated material and fill soil would be removed. ***Alternative S-3A*** (limited removal and off-site disposal), ***Alternative S-5A*** (limited removal and ex-situ thermal treatment), and

Alternative S-5B (limited removal and incineration) will also highly effective and permanent over the long term because these responses will result in the removal of a significant mass of contamination. ***Alternative S-6*** (limited removal and treatment by soil washing) will provide low moderate to high levels of effectiveness and permanence over the long term; effectiveness will depend upon the reduction in contaminant concentrations that can be achieved with this technology which cannot be determined without a treatability study. The long-term effectiveness of ***Alternatives S-4A*** and ***S-4B*** (limited and unlimited removal and on-site disposal) is considered low to moderate because contaminants will remain on site in a disposal cell constructed at Kreher Park. The long-term effectiveness of ***Alternative S-2*** (containment using engineered surface barriers) is considered low because constituents will remain at the site beneath the surface barriers. However, for ***Alternatives S-2***, ***S-4A***, and ***S-4B***, contaminated material will be contained and inaccessible to humans or biota, thereby reducing risk.

If properly implemented, the long-term effectiveness and permanence for all alternatives (except ***Alternative S-1)*** can be achieved for all active remedial responses for soil. Surface barriers (Alternative S-2) must be implemented in conjunction with a remedial response for groundwater to be more effective.

6.5.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

Reduction of toxicity, mobility, or volume of hazardous materials through treatment considers the treatment processes used, the volume or amount and degree to which it destroys or treats hazardous materials; the expected reduction in toxicity, mobility, or volume provided by the alternative; the extent to which the treatment is irreversible; and the types and quantities of residuals that will remain following treatment. ***Alternative S-1*** (no action) will not result in a reduction in the toxicity, mobility, or volume of contaminated soil. ***Alternative S-3B*** (unlimited removal and off-site disposal) will result in the highest degree of reduction of toxicity, mobility, and volume of impacted material because all contaminated soil and fill material will be removed. ***Alternative S-3A*** (limited removal and off-site disposal), ***Alternative S-5A*** (limited removal and ex-situ thermal treatment), and ***Alternative S-5B*** (limited removal and incineration) will also result in a high degree of reduction of toxicity, mobility, and volume of impacted material because these remedial responses will remove a significant contaminant mass. ***Alternative S-6*** (limited removal and treatment by soil washing) will result in a moderate to high degree of reduction of toxicity, mobility, and volume of contaminated soil, but will depend upon the reduction in contaminant concentrations that can be achieved with this technology. ***Alternatives S-4A*** and ***S-4B*** (limited and unlimited removal and on-site disposal) will offer a low to moderate reduction in the toxicity, mobility, and volume of contaminated soil at the Site. It will effectively reduce the toxicity and a significant volume of contaminated soil at the upper bluff area and former coal tar dump area, but this material will be placed in a disposal cell at Kreher Park, which although reduces the mobility of contaminants does not reduce the volume or toxicity at Kreher Park ***Alternative S-2*** (containment using engineered surface barriers) will not reduce the toxicity or and volume of contaminated soil in unexcavated areas, but it will limit the mobility of contaminants by reducing infiltration, which will minimize contaminant leaching to groundwater.

6.5.5 Short-term Effectiveness

Short-term effectiveness considers potential implementation risks to the community and site workers, environmental impacts, and time required to achieve RAOs. Implementation of ***Alternative S-1*** (no action) will not achieve RAOs or improve environmental impacts in the short-term. Because there is no remediation, there will be no exposure to the community and workers. The remaining alternatives will improve environmental impacts in the short-term, but require significant effort to protect the community and workers during remediation. Implementation of ***Alternative S-3B*** (unlimited removal and off-site disposal) will result in the most significant on and off-site disturbance and require the highest levels of effort for this protection. ***Alternatives S-4A*** and ***S-4B*** (limited removal and on-site disposal) will result in no off-site disturbance; site disturbance will be limited to the site, and will require a moderate level of effort for protection. ***Alternative S-2*** (containment using engineered surface barriers) will results in minimal on-site disturbance, and no off-site disturbance. Because the remaining alternatives include limited removal of highly contaminated soil, they will require high levels of effort for worker and community protection. If properly implemented, all alternatives, can achieve short term effectiveness for soil. Surface barriers (***Alternative S-2***) must be implemented in conjunction with a remedial response for groundwater to be more effective.

6.5.6 Implementability

Implementability considers technical feasibility, administrative feasibility, and the availability of services and materials. ***Alternative S-1*** (no action) will require the least amount of effort for implementability. Additionally, because no remedial action will occur, there will be no difficulty in implementing additional remedial actions at a later date. ***Alternative S-3B*** (unlimited removal and off-site disposal) will result in significant site disturbance, and will be the most difficult to implement. ***Alternative S-6*** (limited removal and treatment by soil washing) may require a pilot test to evaluate its implementability. The remaining limited removal alternatives are highly implementable.

6.5.7 Cost

Preliminary cost estimates for potential remedial alternatives for soil include site preparation, excavation, excavation de-watering, transportation and disposal, on-site treatment, and site restoration. There are no costs associated with ***Alternative S-1*** (no action) because none of these activities will be completed. For the upper bluff area, the ***Alternatives S-3B*** (unlimited removal and off-site disposal) and ***Alternative S-5B*** (limited removal and incineration) yielded the highest costs. ***Alternative S-6*** (limited removal and treatment by soil washing) yielded the next highest cost, following by ***Alternative S-5A*** (unlimited removal and on-site thermal treatment), ***Alternative S-3A*** (limited removal and off-site disposal), and. ***Alternatives S-4A*** and ***S-4B*** (limited and unlimited removal and on-site disposal) yielded lower costs for the upper bluff area. ***Alternative S-2*** (containment using engineered surface barriers) would be the lowest cost remedial response for soil in the upper bluff area, but would likely need to be completed in conjunction with a groundwater remedial response to be effective.

Alternative S-3B (unlimited removal and off-site disposal) also yielded the highest cost for Kreher Park. ***Alternative S-4B*** (unlimited removal and on-site disposal at Kreher Park) yielded the next highest cost followed by ***Alternative S-6*** (limited removal and treatment by soil washing), , ***Alternative S-5A*** (limited removal and on-site thermal treatment), ***Alternative S-2*** (containment using engineered surface barriers) ***Alternative S-5B*** (limited removal and off-site incineration), and ***Alternative S-4A*** (limited removal and on-site disposal), ***Alternative S-3A*** (limited removal and off-site disposal) yielded the lowest cost.

6.5.8 Summary

Based on this evaluation, unlimited removal and off-site disposal (***Alternative S-3B***) will provide the highest long-term benefit. However, this benefit is outweighed by the costs associated with this alternative, and potential short term and long term impacts during implementation. Although removal of all wood waste and fill soil from Kreher Park may be acceptable to the Agency, it may not be acceptable to the community if it results in the loss of future use for the park (i.e. restoration as shallow lakebed or wetland). Potential remedial alternatives requiring limited removal are more cost effective. Limited removal and off-site disposal (***Alternative S-3A***), limited and unlimited removal and on-site disposal (***Alternatives S-4 and S-4B***), and limited removal and thermal treatment (***Alternative S-5A***) will provide long-term benefits with the minimal short-term implementation issues. Off-site incineration (***Alternative S-5B***) could also provide long-term benefits with the minimal short-term implementation issues, but at a much higher cost. A pilot test will be needed to further evaluate the feasibility of limited removal and on-site soils washing (***Alternative S-6***) to ensure its effectiveness, but it could also provide long-term benefits with the minimal short-term implementation. Although containment using surface barriers (***Alternative S-2***) will prevent direct contact with surface contamination thereby reducing the risk to human health, it would need to be used in combination with other remedial alternatives for soil and groundwater for maximize effectiveness. The no action alternative (***Alternative S-1***) while costing little to nothing, will not provide any long-term protection, and should not be considered.

7.0 Development and Evaluation of Remedial Action Alternatives – Groundwater

7.1 Remedial Action Objectives for Groundwater

The general goal of RAOs is to protect human health and environmental receptors at risk from contaminants at the site. These objectives are subject to the nine Superfund criteria. As described in the RAO Tech Memo (URS 2007b) preliminary RAOs for groundwater are as follows:

- Protect human health by eliminating exposure (direct contact, ingestion, inhalation) to groundwater with COPCs in excess of regulatory or risk-based standards; reduce contaminant levels in groundwater to meet MCLs and State of Wisconsin Drinking Water Standards
- Protect the environment by controlling the off-site migration of contaminants in groundwater to surrounding surface water bodies which would result in exceedance of ARARs for COPCs in surrounding surface waters.
- Conduct NAPL removal whenever it is necessary to halt or contain the discharge of a hazardous substance or to minimize the harmful effects of the discharge to the air, land or water.

No COPCs were initially identified in the HHRA for groundwater because groundwater is not used as a potable water supply. However, currently there is no restriction on groundwater use in the area of known contamination. Exposure to contaminated groundwater and accompanying NAPLs can potentially occur via the following exposure scenarios:

- Construction worker exposure to shallow groundwater infiltrating trenches at Kreher Park; and
- Trespasser exposure to groundwater infiltrating the lower level of the former WWTP.

NAPL encountered in the Kreher Park fill, ravine fill, NSPW property and Copper Falls aquifer are a source for the dissolved phase plumes identified in groundwater in each unit at the Site. RAOs for NAPL within these units are based on ch. NR 708.13, WAC which states the following:

> *Responsible parties shall conduct free product removal whenever it is necessary to halt or contain the discharge of a hazardous substance or to minimize the harmful effects of the discharge to the air, lands or waters of the state. When required, free product removal shall be conducted, to the maximum extent practicable, in compliance with all of the following requirements:*

(1) *Free product removal shall be conducted in a manner that minimizes the spread of contamination into previously uncontaminated zones using recovery and disposal techniques appropriate to the hydrologic conditions at the site or facility, and properly reuses or treats discharges of recovery byproducts in compliance with applicable state and federal laws.*
(2) *Free product removal systems shall be designed to abate free product migration.*
(3) *Any flammable products shall be handled in a safe and competent manner to prevent fires or explosions.*

Using the above criteria, alternatives for the removal of NAPL are further refined in this document.

7.2 Screening of Remedial Action Alternatives – Groundwater

7.2.1 Chemicals of Potential Concern – Groundwater

As with soil, screening focused on VOCs and PAHs contained in MGP tar waste as the primary COPCs.

7.2.2 Screening of Remedial Alternatives – Groundwater

Potential remedial alternative alternatives capable of preventing direct contact and ingestion of contaminated groundwater or reducing the toxicity and mobility of groundwater contamination at the Site are summarized in Table 7-1. Those retained after the Alternatives Screening Technical Memorandum (see Appendix A1) are shown in bold in Table 7-1.

Table 7-1 - Summary of Groundwater Technologies Reviewed
(Alternatives in bold are retained)

General Response Action	Remedial Technology	Process Option
No Action	**None**	**Not Applicable**
Institutional Controls	**Physical, land use, or legislative restrictions.**	Fencing **Groundwater use/Deed restriction** **Legislative action**
Monitored Natural Recovery	**Monitored Natural Attenuation**	Soil monitoring **Groundwater monitoring**
Containment	Deep well injection	Inject liquid waste into deep geologic formation below usable aquifers.
	Engineered Vertical Barrier	**Sheet piling and/or slurry wall** Concrete barriers Natural barrier
	Groundwater Extraction	**Down gradient extraction wells (retained for upper bluff and Kreher Park only)** **Subsurface interceptor trenches/drains**

Table 7-1 - Summary of Groundwater Technologies Reviewed (Alternatives in bold are retained)

General Response Action	Remedial Technology	Process Option
In-Situ Treatment	**Biological Treatment**	Oxygen enhancement (air/ozone sparging) Oxygen enhancement with chemical oxidation Injection/Re-circulation wells/in well stripping
	Chemical Treatment	**Ozone sparging** **Chemical oxidation**
	Physical//Chemical Treatment	**Surfactant** **Permeable Reactive Barrier Walls**
	Thermal Treatment	Radio Frequency/Electromagnetic Heating **Electrical Resistance Heating** **Steam Injection** **Dynamic Underground Stripping** Hot Air Injection
Removal	**NAPL Excavation** **Groundwater Extraction**	**Removal of saturated zone soils** **Removal of NAPL and/or dissolved phase contaminants (conventional pumping)** **Multiphase vacuum recovery** **Surfactant injection with multiphase vacuum recovery**
Ex-Situ Treatment	**On-site Treatment** Off-site Treatment	**Gravity Separation** **Air Stripping** **Carbon Filtration**

7.3 Development of Potential Remedial Alternatives for Groundwater

Groundwater remedial technologies retained for screening were used to develop potential remedial alternatives for groundwater. Remedial alternatives for groundwater presented in this report are summarized in Table 7-2, included at the end of this section. A description of each remedial alternative follows.

7.3.1 Alternative GW-1 - No Action

The "no action" alternative for groundwater was retained as required by the NCP as a basis for comparing the other alternatives. The NCP at Title 40 Code of Federal Regulations (40 CFR §300.430(e)(6)) provides that the no-action alternative should be considered at every site. Implementation of no further action consists of leaving contaminated groundwater in place; no engineering, maintenance, or monitoring will be required.

7.3.2 Alternative GW-2 -Containment Using Engineered Surface and Vertical Barriers

Containment for groundwater contamination consists of the utilization of natural or man-made barriers to prevent potential exposure to or migration of contaminants with subsurface contamination. Containment alternatives retained for screening and evaluated in this report include engineered surface barriers, vertical barrier walls installed in the aquifer, and extraction wells (barrier wells). Surface barriers eliminate the direct contact exposure pathway. They also can reduce contaminant leaching from the unsaturated zone, by restricting infiltrating water from contacting contaminated soil at areas where contaminated soil is present. Vertical barrier walls and barrier wells prevent the off-site migration of contaminants with groundwater. Engineered surface barriers, vertical barrier walls, and barrier wells are described below.

Engineered Surface Barrier

Engineered surface barriers are considered passive containment alternatives because the contaminated zone is not disturbed, and only minimal maintenance is required following implementation. Surface barriers include the following:

- Asphalt cap;
- Low permeability soil cap (i.e. 2 feet of clay with hydraulic conductivity of less than 10^{-7} cm/sec);
- Multi-layer cap with a minimum two-foot thick clay barrier, drainage layer, soil and vegetated top soil cover; and,
- Multi-layer cap with geomembrane (a minimum two-foot thick clay barrier, geomembrane, drainage layer, soil and vegetated top soil cover.

At the upper bluff area, asphalt caps over the filled ravine as surface barriers will be compatible with existing and future site use. At Kreher Park, a low permeability soil cap could be placed over the entire 11.6 acre parcel, but installation of a clay cap may require the removal of the marina parking lot, Marina Drive, and the former WWTP. To ensure the integrity of the clay cap, it may not be possible to maintain roads, parking lots, and buildings. Consequently, smaller surface barriers at select areas were also evaluated. These smaller surface barriers will be designed to be compatible with existing and future site use, and include asphalt pavement for the marina parking lot and a low permeability cap for the former coal tar dump. Asphalt pavement over the gravel covered marina parking lot will reduce infiltration at this area. A surface barrier over the former coal tar dump area will reduce contaminant leaching from the unsaturated zone if contaminated soil remains in place. If the WWTP is removed, a clay cap or asphalt pavement could be installed at this area. A surface barrier may not be needed at the remaining areas.

Multi-layer caps will be compatible with on-site and off-site disposal options for soil and the CDF for sediment. A multi-layer cap will also be compatible at areas of unexcavated soil, especially at Kreher Park. Single layer asphalt and low permeability caps will satisfy at a minimum satisfy 40 CFR Subtitle D requirements, and multi-layer caps will satisfy 40 CFR Subtitle C requirements. As with potential soil remedial alternatives (evaluated in section 6.0), surface barriers will be included as key elements of the potential groundwater and sediment remedial alternatives.

Barrier Wells

Barrier wells are considered active containment alternatives because long-term operation (groundwater extraction), maintenance, and monitoring will be required. Down gradient barrier wells were retained for groundwater at the upper bluff and for the saturated fill unit at Kreher Park. Properly engineered, these wells will prevent contaminants from migrating off site with groundwater. However, down gradient barrier wells were not considered for the Copper Falls aquifer. Regional groundwater flow conditions in the Copper Falls indicate that a potential stagnation zone beneath the center of Kreher Park has prevented the dissolved phase plume from migrating beyond the shoreline. Additional hydrogeologic and groundwater quality data will be required to ensure that contaminants will not migrate beyond the Kreher Park shoreline.

Well EW-4 was installed at the mouth of the filled ravine to prevent water discharging to the seep area at Kreher Park; it has been in operation since 2002. A final remedy for shallow groundwater in the ravine could include continued operation of EW-4, installation of additional extraction wells, or future operation of EW-4 along with a vertical barrier wall installed down gradient from the extraction well (use of EW-4 will reduce the hydraulic head behind the vertical barrier). An evaluation of the volume of groundwater discharging from the filled ravine and a capture zone analysis for EW-4 will be necessary to evaluate which alternative will be more effective. Continued use of EW-4 as a barrier well for the upper bluff, and barrier wells for shallow groundwater at Kreher Park are evaluated with Alternative GW-9 (removal using groundwater extraction).

Vertical Barrier Walls

Vertical barrier walls consist of a slurry wall or sheet piling installed around the perimeter of the contaminated groundwater zone. A slurry wall is a low permeability barrier constructed by placing a low permeability material (slurry) in a trench around the perimeter of the contaminated groundwater mass. Sheet piling will consist of inter-locking sheets of steel pilings that form a continuous wall installed around the perimeter of the contaminated groundwater mass. Vertical barrier walls are also considered active containment alternatives because contaminated material may be disturbed during construction, and/or long-term maintenance such as groundwater extraction from the contained area may be required.

Engineered vertical barrier walls were retained for further evaluation as potential containment alternatives for shallow contaminated groundwater encountered in the ravine fill at the upper bluff and at Kreher Park. However, vertical barrier walls would not be feasible for the underlying Copper Falls aquifer because this deep aquifer is confined by the Miller Creek Formation. Installation of a barrier wall for contaminants in the Copper Falls aquifer will require penetration of the Miller Creek Formation which will likely compromise the long-term integrity of this confining unit.

.For shallow groundwater, both types of vertical barriers could be anchored into the underlying low permeability Miller Creek Formation to create a barrier that will prevent contaminants in the shallow fill units from migrating off site with groundwater. However, because groundwater in the filled ravine discharges to Kreher Park, vertical barriers will be used to funnel groundwater from the filled ravine to Kreher Park, which will be enclosed by vertical barrier walls.

Engineered surface barriers will be used with vertical barriers to minimize groundwater recharge to contained areas from infiltration. At Kreher Park, vertical barriers may be also used in combination with containment or dredging alternatives evaluated for nearshore sediment described in Section 8.0. The location of the vertical barrier wall at Kreher Park is shown on Figure 7-1. Key elements for the conceptual design of a sheet pile vertical barrier wall around the perimeter of Kreher Park follows:

1. Site preparation will include clearing and grubbing of small trees and bushes along the bluff and near the former seep area as needed.
2. Although the former waste-water treatment plant will be located within the contained area, demolition of this dormant facility may be required.
3. A vertical barrier wall will be placed around the perimeter of Kreher Park. This vertical barrier will consist of a sheet pile wall anchored into the underlying Miller Creek Formation.
4. The sheet pile wall along the shoreline will be installed at an approximate depth of 25 feet below existing grade to allow the off-shore removal of sediment to a depth of ten feet adjacent to the sheet pile wall. The sheet pile wall on the south, east, and west sides of Kreher Park will be installed at an approximate depth of 16 feet below existing grade.
5. Surface barriers will be installed over the filled ravine to minimize groundwater recharge from infiltration, and the sheet pile wall on the south side of Kreher Park will terminate on the east and west flanks of the filled ravine to create a "funnel" for shallow groundwater discharge into Kreher Park.
6. A groundwater diversion trench will be installed between the remainder of the south wall and the upper bluff area to divert groundwater that currently seeps from the upper bluff area into the Kreher Park fill unit.
7. At Kreher Park, site restoration will include installation of new asphalt pavement over the marina parking lot to minimize infiltration in this area. Additionally, a low permeability soil cap will be placed over the former coal tar dump area, and if applicable, a soil cap over the disposal cell.
8. Regrading and a storm-water basin will be constructed within the confined area to manage storm-water and restrict infiltration.
9. Long-term operation and maintenance of the facility will include the removal of contaminated groundwater, and annual inspection of surface barriers. A minimum of 15 groundwater extraction wells will be installed to remove groundwater and reduce the hydraulic head within the confined area. Contaminated groundwater will be conveyed to a treatment system constructed on-site. The treatment system will include an oil water separator, transfer pumps, and air stripper. This remediation equipment will be housed in a small on-site treatment building.

Institutional controls (i.e. deed restrictions) will likely be implemented as part of this remedial response to prevent exposure to groundwater contamination remaining within the contained area. Long-term operation and maintenance will include groundwater monitoring to confirm contaminants are not migrating from the contained area. This will include fluid level monitoring and groundwater extraction to ensure the hydraulic head within the confined area remains at or below lake level.[21].

Although a cap for the entire Kreher Park area will result in significant site disturbance and additional implementation cost, long-term operation, maintenance, and monitoring (OM&M) costs may be lower if it can significantly reduce the volume of groundwater extraction and treatment that is required. To evaluate implementation and OM&M costs, annual groundwater recharge at Kreher Park from infiltration was evaluated for existing conditions, for partial caps (asphalt pavement for marina parking lot and clay cap for former coal tar dump area) with vertical barriers, and for a low permeability cap and vertical barriers for the entire park. Calculation and assumption are described in detail in Appendix D2, and results (the nearest 100 gallons) are summarized below.

Existing Conditions	3,685,000 (gallons)
Partial Cap	2,245,400
Entire Cap	892,900

As shown above, partial caps will reduce annual groundwater recharge from 3,685,000 gallons to 2,245,374, and a complete area cap will reduce annual recharge to 898,900 gallons. Partial caps will result in a 39-percent reduction in recharge, and capping all of Kreher Park will result in a 75 or 76-percent reduction in recharge. Estimated costs for partial caps are included as Alternative GW-2A, and estimated costs for capping all of Kreher Park and to further reduce the volume of groundwater extraction required is included as Alternative GW-2B.

7.3.3 Alternative GW-3 - In-situ Treatment Using Ozone Sparge

Ozone sparging is an in-situ chemical oxidation technology that can be used to oxidize and degrade contaminants in groundwater. Because ozone is a gas, it can be injected into the saturated zone as a gas via sparging. Sparging consists of injecting air or oxygen rich ozone into an aquifer as a gas through small diameter sparge wells. Commercially, ozone is generated by a high voltage discharge through air or oxygen in an ozone generator. Generally, yields are on the order of 1 to 3-percent ozone by volume in air and 2 to 6-percent ozone by volume in oxygen. In water, ozone decomposes to form free radicals. These free radicals are strong oxidizers and react with contaminants in water to form carbon dioxide and water. As an additional benefit, ozone treatment increases the dissolved oxygen level in the water when any un-reacted free radicals combine to form water and oxygen; the dissolved oxygen content in groundwater promotes biodegradation of contaminants.

[21] Groundwater recharge at Kreher Park results from seepage from the upper bluff area and infiltration. Groundwater seepage from the upper bluff area can be diverted, and infiltration into the contained area can be controlled by using surface barriers over the marina parking lot and former coal tar dump area. A cap could also be placed over the entire park to reduce infiltration, but all recharge can not be eliminated. Long-term groundwater extraction may be needed to reduce the hydraulic head within the contained area.

Ozone sparging is typically used for dissolved phase contamination, but is typically not used in areas where NAPL is present. If used for NAPL contamination, groundwater extraction will likely be needed because ozone/air injection may displace NAPL and/or cause a chemical reaction increasing the mobility of NAPL. This mobilized material is then recovered via extraction wells. Air/ozone sparging was retained for further evaluation as a potential in-situ treatment alternative for contaminated shallow groundwater encountered at the upper bluff and at Kreher Park, and in the underlying Copper Falls aquifer. The layout of an ozone sparge system for the shallow groundwater at the upper bluff and at Kreher Park is shown on Figure 7-2A. The layout of an ozone sparge system for the Copper Falls aquifer is shown on Figure 7-2B. Key elements for the conceptual design of an ozone sparging system for shallow groundwater at the upper bluff area and at Kreher Park, and for the Copper Falls aquifer follows:

1. All sparge wells will be installed in soil borings advanced with a hollow stem auger by a rotary drill rig.
2. Sparge wells will be installed on approximate 50-foot diameter centers, and one control panel will inject ozone into a cluster of 12 sparge wells. A pilot test will be necessary to obtain information for designing of the sparge well system.
3. One control panel will be needed for shallow groundwater in the filled ravine.
4. Eight control panels will be needed for shallow groundwater at Kreher Park.
5. Six control panels will be needed for groundwater in the underlying Copper Falls aquifer.
6. All air lines between the sparge wells and control panels will be buried in shallow trenches.
7. For the Copper Falls aquifer, the existing groundwater extraction system will be operated concurrent with the ozone sparge system to recover NAPL; treatment of contaminated groundwater and NAPL recovery is evaluated further with Alternative GW-9.

Although this technology can also be used for contaminated shallow groundwater in the ravine fill and at Kreher Park, buried structures (the former gas holders) and man made debris (wood waste, bricks, cinders, etc.) will interfere with installation and optimum delivery. Additionally, injecting into fill soil, which exhibits a wide range of physical characteristics (permeability in particular), may limit the effectiveness of this in-situ technology (experience with the SITE demonstration during 2006-2007 confirms these site conditions (Appendix B1).

The ozone sparge system may need to be operated for several years, and long-term groundwater monitoring will be required to evaluate the effectiveness of the sparging and subsequent natural attenuation. Institutional controls will also be utilized for this option.

7.3.4 Alternative GW-4 - In-situ Treatment using Surfactant Injection and Dual Phase Recovery

Physical/chemical treatment includes the use of surfactants to enhance the removal of NAPL. Surfactant injection is an in-situ injection technology. Surfactants are “surface active agents” that reduce the interfacial tension between NAPL and water by adsorbing at the liquid-liquid interface, which can result in an increase in the mobility of NAPL. Injection can also displace oil trapped within the aquifer media. Groundwater remediation using surfactant is a two phase approach involving injection of surfactant and recovery of fluids. Surfactant is injected to displace or mobilize NAPL, which is then recovered slowly by groundwater extraction or rapidly by vacuum enhancement. Vacuum enhancement is also referred to as dual phase or multiphase extraction because an induced vacuum is used to remove air, water, and NAPL simultaneously.

Although this technology can also be applied to contaminated groundwater in the ravine fill and at Kreher Park, site conditions may prevent implementation and limit effectiveness. Buried structures (the former gas holders) and man made debris (wood waste, bricks, cinders, etc.) may prevent proper installation of injection/extraction wells. Additionally, fill soil, which exhibits a wide range of physical characteristics (permeability in particular), may limit the effectiveness of this in-situ technology. Consequently, it was not retained for screening as a shallow groundwater remedial response. For the Copper Fall aquifer, dual phase recovery was retained for screening. The layout of injection/extraction wells for the underlying Copper Falls aquifer is shown on Figure 7-3. Key elements for the conceptual design of surfactant injection and dual phase recovery system the Copper Falls aquifer follows:

1. A minimum of 30 small diameter injection/extraction wells will be installed in borings advanced below the Miller Creek / Copper Falls interface where NAPL has been identified. (Existing piezometers in this area will also be utilized).
2. Each well will be constructed with 2-inch diameter SCH 80 PVC well casing and screen. A sand pack will be placed around a well screen five feet in length.
3. Surfactant will be injected into wells where NAPL has been encountered to lower the interfacial tension that restricts the movement of non-mobile NAPL in the aquifer.
4. After allowing the surfactant to penetrate the formation for 24 to 48 hours, NAPL and groundwater is then removed by an induced vacuum and treated on site. Fluids will be removed from the injection/extraction wells by vacuum enhancement.
5. Multiple applications will be needed to remove NAPL to the extent practicable; for this evaluation it is assumed that a minimum of five applications of surfactant will be needed. Fluid levels will be checked one month after treatment, and the next application will be completed if NAPL remains. To remove a significant mass of mobile NAPL, it is assumed that fluids will be removed monthly for six months following the fifth application.
6. Recovered fluids will be treated on site prior to discharge to the sanitary sewer. This will require upgrades to the existing treatment system.
7. A pilot test using existing piezometers MW-2AR, MW-4A, MW-10B, MW-13A, MW-15A, MW-19A, MW-21A, and MW-22A screened at the Miller Creek / Copper Falls interface should be completed prior to full scale remediation to determine if a mobile vacuum truck or fixed based system is needed for dual phase recovery. The pilot test will also be used to evaluate the mobile mass of NAPL that can be removed, the number of applications needed and the most efficient frequency of fluid removal between injections.

Surfactant injection and dual phase recovery can likely be completed within one year, but the existing groundwater remediation system will be operated for several more years. Treatment of contaminated groundwater and NAPL recovery is evaluated further with Alternative GW-9.

Long-term groundwater monitoring will be required to evaluate natural attenuation and institutional controls will be implemented as part of this option.

7.3.5 Alternative GW-5 - In-situ Treatment using Permeable Reactive Barrier Walls

Physical/chemical treatment also includes the use permeable reactive barrier (PRB) walls to treat contaminated groundwater migrating from source areas. PRB walls are limited to subsurface conditions where contaminants are found above a continuous aquitard at a depth within the vertical limits of trenching equipment. PRB walls are installed across the flow path of a contaminant plume, allowing the plume to passively move through the wall. There are two types of barriers, 1) permeable reactive barriers and 2) in-place bioreactors. Both allow the passage of water while restricting, via reaction with barrier materials, the movement of contaminants. Contaminants are degraded, adsorbed, or retained in/ by the barrier material.

PRB walls were not retained for the underlying Copper Falls aquifer; construction of the PRB would require penetration of the overlying Miller Creek Formation. The Miller Creek forms a confining unit for the Copper Falls aquifer, and construction will compromise the integrity of the confining unit. However, a PRB could be used as a remedial alternative for shallow groundwater. Instead of installing PRB walls in source areas, they are typically installed at down gradient locations to treat contaminated groundwater before it migrates off site. PRB walls are typically constructed as “gate” and “funnel” systems; gates are vertical barriers used to direct groundwater flow to the PRB wall, which functions as a funnel and treats groundwater before it leaves the site.

Because Kreher Park is filled lakebed, the lake is in hydraulic connection with shallow groundwater at Kreher Park. Vertical barriers can be used to prevent flow between Kreher Park and the lake. However, groundwater within the contained area may still be recharged by infiltration. Rather than extracting contaminated groundwater, shallow groundwater will be allowed to discharge from Kreher Park through the PRB wall. PRB walls are passive systems designed for long-term operation to control/ treat contaminants in-situ with normal groundwater migration. A sheet pile or slurry wall (vertical barrier) will be installed around the east, north, and south sides of Kreher Park to form the gate, and a down gradient PRB wall will be installed along the west side as the funnel. Rather than install another PRB wall for the filled ravine, a single PRB wall at the northwest perimeter of the park will treat shallow groundwater discharging from the entire site. The layout of the PRB wall, vertical barrier wall, and engineered surface barrier is shown on Figure 7-4. Key elements for the conceptual design of a PRB wall for shallow groundwater at the site follow:

1. Site preparation will include clearing and grubbing of small trees and bushes along the bluff and near the former seep area as needed.
2. Although the former waste-water treatment plant will be located within the contained area, demolition of this dormant facility may still be required as part of the overall remediation to accommodate future site use.

3. A vertical barrier wall will be placed on the north, east, and south sides of Kreher Park. This vertical barrier will consist of a sheet pile wall anchored into the underlying Miller Creek Formation.
4. The sheet pile wall along the shoreline will be installed at an approximate depth of 25 feet below existing grade to allow the off-shore removal of sediment to a depth of ten feet. The sheet pile wall on the south, east, and west sides of the Kreher Park will be installed at an approximate depth of 16 feet below existing grade.
5. A trench will be excavated on the west side of the Kreher Park for the PRB wall. The wall will be constructed with a porous layer of granular activated carbon to remove dissolved phase organic compounds prior to discharge.
6. The base of the PRB wall would be placed several feet below lake level, and the top of the PRB wall would be placed several feet above lake level. This will allow groundwater within the confined area to discharge as groundwater elevations in the contained area and lake levels fluctuate.
7. Monitoring wells will be installed on both side of the PRB wall, and water levels will be monitored to confirm that groundwater is flowing through the PRB wall.
8. Surface barriers will be installed over the filled ravine to minimize infiltration, and the sheet pile wall on the south side of Kreher Park will terminate on the east and west flanks of the filled ravine to create a “funnel” for shallow groundwater discharge into Kreher Park.
9. A groundwater diversion trench will be installed between the remainder of the south wall and the upper bluff area to divert groundwater seepage into the Kreher Park fill unit.
10. Site restoration will include installation of new asphalt pavement over the marina parking lot. A low permeability soil cap will be placed over the former coal tar dump area to minimize potential exposure to subsurface contamination and minimize leaching of contaminants from the unsaturated zone Regrading will be performed and a storm-water basin constructed within the confined area to manage storm-water and restrict infiltration.

The length and thickness of the PRB wall must be designed to allow adequate flow and treatment of contaminated groundwater discharging from the contained area. The thickness of the PRB wall increases retention time and treatment of contaminated groundwater. However, increasing the thickness of the PRB wall may reduce the volume of water that can pass through each linear foot of the wall. The length of the PRB wall can be increased to allow for increased flow through the wall, but increasing the length will increase the cost. Therefore an accurate estimate of the volume of water that will pass through the PRB wall is critical to the design. Discharge through the PRB wall will be influenced by 1) fluctuating lake levels, and 2) groundwater recharge from infiltration within the contained area. The PRB could function with or without impermeable surface barriers. However, because the length on the east side of the park is limited, surface barriers will likely be used to restrict groundwater recharge from infiltration, which will reduce the volume of groundwater passing through the PRB wall. A numerical flow model evaluating surface infiltration coupled with fluctuating lake levels may be needed to determine the length of PRB wall required.

Long-term operation and maintenance of the PRB wall will be minimal. Groundwater monitoring will be needed to evaluate the effectiveness of the PRB wall. The reactive material used to construct the PRB may need to be replaced if NAPL migrates from the source area and permeates the PRB, or the reactive material is becomes saturated with contaminants removed from groundwater passing through the wall. Fluid levels will also be monitored to ensure the hydraulic head within the confined area remains at or slightly above lake level. Institutional controls will likely be implemented to prevent direct contact with subsurface contaminants within contained areas as part of this remedial option.

7.3.6 Alternative GW-6 – Treatment using Chemical Oxidation

Chemical oxidation introduces strong oxidizing chemicals such as permanganate and peroxide into the subsurface to degrade VOCs and PAH compounds to CO_2 and H_2O end products. Permanganate or peroxide could be injected as liquid reagents through boreholes, wells, or mixed with a backhoe in shallow trenches. Chemical oxidation has an added benefit of enhancing biodegradation by increasing oxygen concentrations in the subsurface. Chemical oxidation could be performed on saturated and unsaturated zone soils by injecting chemicals into the subsurface via borings or wells.

In-situ chemical oxidation could be used for unsaturated and saturated zone contamination at the upper bluff. However, existing conditions at the upper bluff area (the NSPW facility building and buried gas holders) and at Kreher Park (wood waste layer) may limit implementability. Mixing reagent in shallow trenches would be the most effective treatment method at Kreher Park because contamination is present at shallow depths at the former coal tar dump area, and would be easily accessible. Because in-situ chemical oxidation reactions can result in the generation of off-gases, primarily CO_2, passive venting or an active SVE system may be required to capture off-gases. The presence of NAPL may require multiple applications to lower contaminant concentrations to acceptable levels. Potential injection locations for in-situ chemical oxidation at the upper bluff and at Kreher Park are shown on Figures 7-5A, and 7-5B, respectively. Key elements for the conceptual design for in-situ chemical oxidation for shallow soil and groundwater at the site follow:

1. Demolition of the center section of the NSPW service center south of St. Claire Street will be required to access contaminated soil beneath the building at the upper bluff area.
2. Between 200 and 300 injection borings will be advanced in the filled ravine using a direct push drill rig[22].
3. For this evaluation it is assumed that approximately 1,500 gallons of reagent will be injected into each boring.
4. A minimum of 10 passive vent wells will be installed in the filled ravine. Each well will be installed to an approximate depth of 20 feet with well screens 10 feet in length. Because the water table will intersect the well screen, these wells may also be used to recover fluids that rise to the surface in response to chemical reactions taking place in the subsurface. Recovered fluids will be placed in a holding tank and discharged to the on-site treatment system.

[22] Direct push was used to advance injection boring for the USEPA SITE pilot test completed at the Site in early 2007.

5. Site restoration at the upper bluff area will include replacement of existing asphalt pavement and new pavement over the footprint of the demolished building south of St. Claire Street. New pavement on the north of St. Claire Street will also be installed to prevent infiltration into this section of the filled ravine.
6. At Kreher Park, site preparation will include clearing and grubbing small trees and bushes along the bluff and near the former seep area as needed.
7. Chemical oxidation at Kreher Park will be completed above and in the wood waste layer where DNAPL is encountered and at the former coal tar dump area by mixing reagent in a shallow excavation.
8. Additionally, between 100 and 150 injection borings will be advanced at the former seep area and near TW-11 where DNAPL has been encountered. A direct push drill rig will be used to advance these borings, and approximately 1,500 gallons of reagent will be injected into each boring. Existing wells MW-7 and TW-11 will be used as passive vent wells in these areas.
9. Site restoration will include installation of new asphalt pavement over the marina parking lot and a low permeability soil cap over the former coal tar dump area to minimize potential exposure to subsurface contamination and minimize infiltration.
10. Regrading and a storm-water basin will be constructed within the confined area to manage storm-water and restrict infiltration.
11. Multiple applications may be needed to reduce contaminant levels to the extent practicable. The estimated remedial costs included in this report assume two applications. The first application will be completed in a regular grid pattern over the treatment area, but additional applications will be completed within the treatment area as needed.

Implementation for the underlying Copper Falls would be more extensive; it may require groundwater extraction rather than soil vapor extraction. The USEPA's SITE program recently completed a demonstration pilot test to fully evaluate the implementability of this alternative at the Site. Additional data will be available in the near future following compilation of pilot test data. Chemical oxidation may also increase the mobility of NAPL recovered by extraction wells resulting in the removal of significant contaminant mass in a short time frame. Preliminary results from the recent SITE program pilot test indicate that injection into areas with NAPL contaminants resulted in an initial vigorous reaction followed by an increase in the mobility and recovery of NAPL. Additional data is currently being collected and will be available in the near future to evaluate NAPL recovery and improvements to groundwater quality. Potential injection locations for in-situ chemical oxidation for the underlying Copper Falls aquifer are shown on Figure 7-5C. Key elements for the conceptual design for in-situ chemical oxidation for the Copper Falls aquifer follow:

1. Between 250 and 500 injection borings will be advanced in the Copper Falls aquifer using a direct push drill rig.
2. For this evaluation it is assumed that approximately 1,500 gallons of reagent will be injected into each boring.
3. Existing extraction wells EW-1, EW-2, and EW-3 will continue to operate during and after reagent injection.

4. A minimum of 7 additional extraction wells will be installed in the Copper Falls aquifer in borings advanced with hollow stem auger using a rotary drill rig.
5. Recovered fluids will be treated on site prior to discharge to the sanitary sewer. This will require upgrades to the existing treatment system.
6. Multiple applications may be needed to reduce contaminant levels to the extent practicable. The estimated remedial costs included in this report assume two applications. The first application will be completed in a regular grid pattern over the treatment area, but additional applications will be completed within the treatment area as needed.

Although chemical oxidation applications can be completed within a short period of time, the groundwater extraction system may be operated for several years; treatment of contaminated groundwater and NAPL recovery is evaluated further with Alternative GW-9. Long-term groundwater monitoring to evaluate natural attenuation and institutional controls will be included with this remedial response.

7.3.7 Alternative GW-7 - In-situ Treatment using Electrical Resistance Heating

Electrical resistance heating (ERH) technology uses electricity applied into the ground through electrodes to heat the formation. This mobilizes contaminants by heating contaminants and groundwater to boiling point, the steam and contaminants are then recovered with a SVE, groundwater extraction, or dual phase system. The ERH electrodes can be installed either vertically to about 100 feet or horizontally beneath buildings. ERH heats the contaminants up to 100 ^{0}C, which raises the vapor pressure of volatile and semi-volatile organic compounds in the soil. For soil and shallow groundwater, this enhances the recovery of volatilized contaminants by SVE. At these high temperatures (100 ^{0}C), ERH can also be used to dry soil, which can create fractures that increase soil permeability resulting in improved recovery of contaminants by SVE. At high temperatures, saturated zone soils can also be heated to high temperatures to create steam that strips contaminants from soil. Treatment of effluent vapors and dissolved phase groundwater contamination will be required before discharge of air and/or water.

Implementation of this technology for shallow soil and groundwater contamination could be completed simultaneously; passive soil venting and groundwater extraction will likely be required. Existing site buildings and buried structures at the upper bluff and the wood waste layer at Kreher Park will likely limit implementation of this alternative for soil and shallow groundwater. Building demolition and removal of the buried structures at the upper bluff area would enhance the implementability of ERH for the underlying Copper Falls aquifer. For shallow soil and groundwater at the upper bluff area and at Kreher Park, and for the underlying Copper Falls aquifer, ERH could be utilized with groundwater extraction to remove DNAPL. Rather than heat soils to create steam, the saturated zone will be heated to between 30^{o}C and 40^{o}C to decrease the viscosity and increase the mobility of NAPL, which is then removed via extraction wells or by a dual phase recovery system. Current Environmental Solutions (CES) reported over 5,000 gallons of product was recovered after the first three months of operation at a former MGP site in Illinois (*Enhanced Free Product Recovery Using Low Temperature In-Situ Heating - An Option For MGP Sites*, CES 2006).

Potential locations for ERH electrodes, passive vent wells, and extraction well for shallow soil and groundwater at the upper bluff and at Kreher Park are shown on Figures 7-6A and 7-6B, respectively[23]. Key elements for the conceptual design for ERH for shallow soil and groundwater at the site follow:

1. Demolition of the center section of the NSPW service center south of St. Claire Street will be required to access contaminated soil beneath the building in the upper bluff area.
2. Installation of a minimum of 200 electrodes at the filled ravine to heat the subsurface to 30^{o} or 40^{o} C to enhance DNAPL recovery.
3. A minimum of 10 passive vent wells will be installed at the filled ravine to allow vapors to escape, and a minimum of four extraction wells will be installed to recover fluids.
4. Treatment of effluent vapors and dissolved phase groundwater contamination will be required before discharge of air and/or water. Vapor-phase carbon adsorption will be used to treat vapors prior to discharge to the atmosphere. Water will be treated by the on-site treatment system prior to discharge to the sanitary sewer; this will require upgrades to the existing treatment system.
5. Site restoration will include replacement of existing asphalt pavement south of St. Claire Street and new pavement north of St. Claire Street to prevent infiltration into the underlying filled ravine.
6. At Kreher Park, site preparation will include clearing and grubbing of small trees and bushes along the bluff and near the former seep area as needed.
7. Installation of a minimum of 150 electrodes at the former seep, former coal tar dump, and TW-11 areas to heat the subsurface to 30^{o} or 40^{o} C to enhance DNAPL recovery.
8. A minimum of 10 passive vent wells and a minimum of four extraction wells will also be installed at the former coal tar dump area; the vent wells will allow vapors to escape and the extraction wells will be used to recover fluids.
9. Site restoration will include installation of new asphalt pavement over the marina parking lot and a low permeability soil cap over the disposal cell and former coal tar dump area to minimize potential exposure to subsurface contamination and minimize infiltration.
10. Regrading and a storm-water basin will be constructed within the confined area to manage storm-water and restrict infiltration.

If a containment alternative is implemented for Kreher Park, treatment of shallow soil and groundwater will not be required. If removal of buried structures is required, ERH may not be as feasible for soil and shallow groundwater as are removal and ex-situ treatment alternatives described in Section 6.0

[23] The conceptual design presented in this FS Report uses passive vent wells to vent vapors, recovery wells to remove fluids, and electrodes to heat the plume to enhance NAPL recovery. Passive vent wells may not be needed. Additionally, ERH may also be accomplished by combining electrodes in the same boring as extraction wells, which will require groundwater extraction from numerous small diameter wells rather than from a few groundwater extraction wells. This issue can be addressed during the design phase.

Potential locations for ERH electrodes and SVE wells for deep groundwater contamination in the Copper Falls aquifer are shown on Figure 7-6C. Key elements for the conceptual design for ERH for shallow the Copper Falls aquifer follow.

1. Demolition of the center section of the NSPW service center will likely be required for shallow soil and groundwater remediation. Demolition of the center and west sections of the NSPW service center will be required to access the underlying Copper Falls aquifer.
2. Removal of the buried gas holders will improve the implementability of ERH for the underlying Copper Falls aquifer.
3. Installation of a minimum of 200 electrodes in the underlying Copper Falls aquifer to heat the subsurface.
4. A minimum of 12 additional extraction wells will be installed, and the three existing groundwater extraction wells would be used to remove contaminated groundwater.
5. Treatment of effluent vapors and dissolved phase groundwater contamination will be required before discharge of air and/or water. Vapor-phase carbon adsorption will be used to treat vapors prior to discharge to the atmosphere. Water will be treated by the on-site treatment system prior to discharge to the sanitary sewer; this will require upgrades to the existing treatment system.

For the purpose of evaluating ERH in this FS Report, we have assumed that groundwater will be extracted for six to 12 months while the ERH system is in operation. We have assumed groundwater extraction rates of 5 to 10 gallons per minute (gpm) for shallow groundwater in the filled ravine, 10 to 20 gpm for shallow groundwater at Kreher Park, and 15 to 20 gpm for the Copper Falls aquifer. This increased flow rate will require upgrades to the existing NAPL treatment system, but long term operation of the treatment system will not be required. ERH can be completed within a short period of time (i.e. several months); therefore we have assumed that continued operation of the groundwater extraction system will not be required. Long-term groundwater monitoring to evaluate natural attenuation and institutional controls will be included with this remedial response.

7.3.8 Alternative GW-8 - In-situ Treatment using Steam Injection (Including Contained Recovery of Oily Wastes (CROW) and Dynamic Underground Stripping (DUS) Processes)

Steam injection physically separates volatile and semi-volatile organic constituents from soil by thermal or mechanical energies. A passive or active SVE and/or groundwater extraction system will be needed to recover volatilized contaminants. Implementation for soil and shallow groundwater remediation can be completed simultaneously. Potential steam injection and recovery wells for shallow soil and groundwater at the upper bluff are shown on Figure 7-7A. Steam injection well location at the former coal tar dump area at Kreher Park are shown on Figure 7-7B. Key elements for the conceptual design for steam injection for shallow groundwater follow.

1. Demolition of the center section of the NSPW service center south of St. Claire Street will be required to access contaminated soil beneath the building in the upper bluff area.

2. Replacement of existing asphalt pavement south of St. Claire Street and new pavement north of St. Claire Street will be required.
3. Installation of a boiler for generation of steam for injection.
4. A minimum of nine steam injection wells and four steam recovery wells will be installed at each area (the filled ravine and the former coal tar dump area).
5. Treatment of effluent vapors and/or dissolved phase groundwater contamination will be required before discharge of air and/or water. Vapor phase carbon may be used to treat vapors prior to discharge to the atmosphere. Water will be treated by the on-site treatment system prior to discharge to the sanitary sewer; this may require upgrades to the existing treatment system.

The Contained Recovery of Oily Wastes (CROW) process is a patented hybrid thermal flushing process that uses steam injection. For the CROW process, hot water is injected with steam to mobilize NAPL toward recovery wells, which then convey the mixture to separators along with an on-site treatment system. This innovative technology has been successfully used at coal tar sites as full-scale remedial applications. Limitations to the technology include groundwater injection and recharge, groundwater chemistry, site accessibility, and utility access. Potential steam injection and recovery wells for shallow soil and groundwater using the CROW method will be similar to the steam injection layout shown on Figures 7-7A and 7-7B.

As shown during the SITE demonstration, injection into the confined Copper Falls aquifer will require high pressures. This will reduce the effectiveness of steam and hot water injection for the deep groundwater. High pressures that could hydraulically fracture the Copper Falls and Miller Creek formations[24]. Alternatively, a patented hybrid steam injection process called Dynamic Underground Stripping (DUS) could be applied for the underlying Copper Falls aquifer. This technology involves groundwater extraction and treatment of contaminated fluids mobilized by heating via a combination of technologies. This process will consist of steam injection; electrical heating; underground imaging; and collection and treatment of effluent vapors, NAPL, and contaminated groundwater. These technologies are utilized as follows:

- Steam injection at the periphery of the contaminated area heating permeable zone soils, which then vaporizes volatile compounds bound to the soil causing contaminant migration to centrally located vapor/groundwater extraction wells;
- Electrical heating of less permeable clays and fine-grained sediments vaporizing contaminants causing migration into the steam zone;
- Underground imaging, primarily Electrical Resistance Tomography (ERT) and temperature monitoring, which delineates the heated area and tracks the steam fronts daily to monitor cleanup, and
- Treating effluent vapors, NAPL, and impacted groundwater as needed before discharge.

Hydrous Pyrolysis/Oxidation (HPO) is a process sometimes completed after contaminants are removed during the DUS phase. HPO consists of steam and air injection, which creates a heated,

[24] The Miller Creek is the confining unit for the Copper Falls, and this unit is thinnest where it was dissected by the former ravine near the former MGP. Fracturing the Miller Creek could create future breaches in the Copper Falls.

oxygenated zone in the subsurface. After the injection is terminated the steam condenses causing contaminated groundwater to migrate to the heated zone where it mixes with the condensed steam and oxygen. Although this may destroy some microorganisms impeding natural biodegradation, HPO enhances biodegradation of residual contaminants by stimulating other microorganisms (called thermophiles) that thrive at high temperatures. A pilot test will be needed to evaluate the effectiveness of HPO after DUS.

Potential steam injection and recovery wells for deep groundwater contamination in the Copper Falls aquifer are shown on Figure 7-7C. Key elements for the conceptual design for DUS for the Copper Falls aquifer follow.

1. Demolition of the center section of the NSPW service center south of St. Claire Street will be required to access the underlying Copper Falls aquifer at the upper bluff area.
2. A minimum of 12 steam injection wells will be installed in the Copper Falls aquifer at the upper bluff area.
3. A minimum of 9 recovery wells will be installed in the Copper Falls aquifer at the upper bluff area.
4. Recovered fluids will be treated on site prior to discharge to the sanitary sewer. This will require upgrades to the existing treatment system.

For the purpose of evaluating steam injection technologies in this FS Report, we have assumed that the groundwater will be extracted for three to six months with steam injection is performed. We have assumed groundwater extraction rates of 5 to 10 gallons per minute (gpm) for shallow groundwater in the filled ravine, 10 to 20 gpm for shallow groundwater at Kreher Park, and 15 to 20 gpm for the Copper Falls. This increased flow rate will require upgrades to the existing NAPL treatment system, but long term operation of the treatment system will not be required. Although steam injection or DUS can be completed within a short period of time, long-term groundwater monitoring will be required to evaluate natural attenuation and institutional controls as final remedial responses.

A pilot test will likely be necessary prior to a full application of DUS at the Site. Information developed for the 2006-2007 SITE ISCO demonstration (injection rates, aquifer chemistry where applicable) will be utilized in the full analyses of this option in the design phase.

7.3.9 Alternative GW-9 – NAPL Removal using Groundwater Extraction Wells

Groundwater extraction uses water as a carrier to remove both NAPL and dissolved phase contamination. Groundwater extraction can be implemented for shallow groundwater contamination encountered at the upper bluff area and Kreher Park as well as the underlying Copper Falls aquifer. The existing interim groundwater extraction interim system currently extracts groundwater from one well installed at the mouth of the filled ravine, and groundwater and DNAPL from three low flow wells installed in the underlying Copper Falls aquifer. Continued operation of this system was evaluated as Alternative GW-9A, and enhanced groundwater extraction was evaluated as Alternative GW-9B. Enhanced removal at the upper bluff area will include installation of additional low flow extraction wells in the Copper Falls aquifer to increase DNAPL removal rates, and continued operation of existing wells EW-1, EW-2, and EW-3. This will also include continued operation of EW-4. However, an evaluation of the volume of groundwater discharged from the filled ravine along with a capture zone analysis for this well will also be required to evaluate utilization of EW-4 for shallow groundwater containment (i.e. barrier wells).. Potential extraction well locations for the Copper Falls aquifer are shown on Figure 7-8A. Key elements for enhanced groundwater and NAPL extraction in the upper bluff area follow.

1. A minimum of 12 extraction wells will be installed in the Copper Falls aquifer.
2. Installation of lateral piping between each extraction well and the existing treatment building.
3. Replacement of existing asphalt pavement south of St. Claire Street and new pavement north of St. Claire Street will be installed to reduce infiltration into the ravine fill.
4. Recovered fluids will be treated on site prior to discharge to the sanitary sewer. This will require upgrades to the existing treatment system.

The groundwater extraction system at the upper bluff area may be operated for an extended period of time. Long-term groundwater monitoring will be required to evaluate natural attenuation and institutional controls will also be implemented as part of this option. Continued operation of the existing groundwater extraction system (Alternatives GW-9A) was also evaluated with Alternatives GW-3 (ozone sparge) and GW-4 (dual phase recovery and surfactant injection). Based on the historical operation of the existing system, a combined groundwater extraction rate of two to three gallons per minute (gpm) was used to evaluate long term operation and maintenance costs. The addition of seven additional extraction wells was evaluated as Alternative GW-6 (chemical oxidation), and Alternative GW-9B included the addition of 12 extraction wells. Additional wells would result in an increase of the combined flow rate to 10 to 15 gpm, which will require an upgrade to the existing treatment system.

Horizontal extraction wells will be used at Kreher Park because shallow groundwater is encountered in a widespread thin fill unit, and fill material has variable permeability in this area. A potential horizontal well configuration for shallow groundwater extraction contamination at Kreher Park is shown on Figure 7-8B. Key elements for the conceptual design for shallow groundwater extraction at Kreher Park follow.

1. Horizontal wells consisting of perforated pipe will be installed in trenches penetrating the saturated fill unit.
2. One trench will transcend the length of the Kreher Park. Lateral trenches will be installed to dissect the former coal tar dump area and the former open sewer area.
3. Recovered fluids will be treated on site prior to discharge to the sanitary sewer. This will require installation of a treatment system at Kreher Park
4. Site restoration will include installation of new asphalt pavement over the marina parking lot and a low permeability soil cap over the former coal tar dump area to prevent potential exposure to subsurface contamination and minimize infiltration.

Groundwater extraction at Kreher Park will require installation of an on-site treatment system that will require operation for an extended period of time. Long-term groundwater monitoring will be required to evaluate natural attenuation and institutional controls will also be implemented as part of this option. For the purpose of evaluating groundwater extraction at Kreher Park, a pumping rate of 50 gallons per minute was used. This flow rate will exceed the estimated annual recharge rate and induce an inward hydraulic gradient at Kreher Park.

Table 7-2.Summary of Potential Groundwater Remedial Alternatives

Alternative	Upper Bluff Area	Kreher Park	Copper Falls Aquifer	Other Groundwater Remedial Technologies Used
Alternative GW-1 No Action	• No removal or treatment of groundwater performed.			• Not applicable
Alternative GW-2A Containment Using Engineered Surface and Vertical Barriers	• Install asphalt pavement as surface barrier over filled ravine. • Install asphalt pavement as surface barrier over filled ravine.	• Install barrier wall around perimeter of Kreher Park fill to prevent off-site migration of contaminants with groundwater. • Install asphalt pavement over marina parking lot, and low permeability soil cap in the former coal tar dump area, or cap the entire park.	• Not evaluated because installation of a vertical barrier wall may jeopardize the integrity of the overlying confining unit.	• Monitored natural attenuation • Institutional controls • Groundwater extraction from contained areas with on site treatment.
Alternatives GW-2B Containment Using Engineered Surface and Vertical Barriers		• Install barrier wall around perimeter of Kreher Park fill to prevent off-site migration of contaminants with groundwater. • Install clay cap meeting ch. NR 500 requirements over the entire park; would require demolition of WWTP.		
Alternative GW-3 In-situ Treatment using Ozone Sparge	• Install sparge wells in the filled ravine south of St. Claire Street.	• Install sparge wells throughout Kreher Park.	• Install of sparge wells in the impacted portion of Copper Falls aquifer. • Continue to operate existing groundwater remediation system to collect NAPL. •	• Monitored natural attenuation • Institutional controls • Groundwater extraction and NAPL recovery with on site treatment.
Alternative GW-4 In-situ Treatment using Surfactant Injection and Removal using Dual Phase Recovery	• Not evaluated because existing conditions (buried gas holders and variable permeability of fill material) may impede effectiveness.	• Not evaluated because existing conditions (wood waste layer and variable permeability of fill material) may impede effectiveness.	• Install a minimum of 30 injection/extraction wells, inject surfactant, and remove fluid monthly for a minimum of one year. • Continued operation of existing NAPL recovery system.	• Monitored natural attenuation • Institutional controls • Groundwater extraction and NAPL recovery with on site treatment.

Table 7-2.Summary of Potential Groundwater Remedial Alternatives

Alternative	Upper Bluff Area	Kreher Park	Copper Falls Aquifer	Other Groundwater Remedial Technologies Used
Alternative GW-5 In-situ Treatment using Permeable Reactive Barrier Walls	• Groundwater from ravine would continue to discharge to Kreher Park. Groundwater discharging from Kreher Park would then pass through a PRB wall for treatment prior to leaving the park.	• Install vertical barrier wall on north, south, and east sides to contain shallow groundwater contamination in the park. • Install PRB wall constructed of GAC on west side of Kreher Park to remove dissolved phase contaminants from groundwater prior to discharge from Park.	• Not evaluated because installation of a PRB wall may jeopardize the integrity of the overlying confining unit.	• Monitored natural attenuation • Institutional controls • Containment using surface and vertical barrier walls
Alternative GW-6 In-situ Treatment using Chemical Oxidation	• Inject reagent through borings advanced into the DNAPL area within the filled ravine south of St. Claire Street. • Install passive vent/recovery wells to vent off-gases and recover fluids • Modify existing treatment system, and treat recovered fluid on site.	• Mix reagent in shallow trench excavated at former coal tar dump area. • Inject reagent through borings advanced into DNAPL areas in former seep area and near well TW-11.	• Inject reagent through borings advanced into the underlying Copper Falls aquifer. • Install additional groundwater extraction wells to collect NAPL. • Modify existing treatment system, and treat recovered fluid on site.	• Monitored natural attenuation • Institutional controls • Soil vapor extraction • Groundwater extraction • Containment using surface and vertical barrier walls
Alternative GW-7 In-situ Treatment using Electrical Resistance Heating	• Install array of electrodes in filled ravine to heat subsurface and enhance the migration of NAPL. • Install additional groundwater extraction wells and vent wells to recover fluids and vapors. • Modify existing treatment system, and treat recovered fluid on site.	• Install array of electrodes above wood waste layer at the former coal tar dump area to heat subsurface and enhance the migration of NAPL. • Install additional groundwater extraction wells and vent wells to recover fluids and vapors. • Modify existing treatment system, and treat recovered fluid on site.	• Install array of electrodes in the underlying Copper Falls aquifer to enhance the migration of NAPL. • Install additional groundwater extraction wells and vent wells to recover fluids and vapors. • Modify existing treatment system, and treat recovered fluid on site.	• Monitored natural attenuation • Institutional controls • Soil vapor extraction • Groundwater extraction • Dual Phase Recovery • Treat air stream from vapor prior to discharge. • Treatment of SVE condensate prior to discharge. • Containment using surface and vertical barrier walls

Table 7-2.Summary of Potential Groundwater Remedial Alternatives

<table>
<tr><th>Alternative</th><th>Upper Bluff Area</th><th>Kreher Park</th><th>Copper Falls Aquifer</th><th>Other Groundwater Remedial Technologies Used</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td><u>Alternative GW-8</u>
In-situ Treatment using Dynamic Underground Stripping (Steam Injection)</td><td>• Install steam injection wells in filled ravine to heat subsurface and enhance the migration of NAPL.
• Install additional groundwater extraction wells and vent wells to recover fluids and vapors.
• Modify existing treatment system, and treat recovered fluid on site.</td><td>• Install steam injection wells above wood waste layer at former coal tar dump area to heat subsurface and enhance the migration of NAPL.
• Install additional groundwater extraction wells and vent wells to recover fluids and vapors.
• Modify existing treatment system, and treat recovered fluid on site.</td><td>• Install steam injection wells in the underlying Copper Falls aquifer to heat subsurface and enhance the migration of NAPL.
• Install additional groundwater extraction wells and vent wells to recover fluids and vapors.
• Modify existing treatment system, and treat recovered fluid on site.</td><td>• Monitored natural attenuation
• Institutional controls
• Soil vapor extraction
• Groundwater extraction
• Treat air stream from vent wells prior to discharge.
• Treatment of vapor condensate prior to discharge.
• Dual Phase Recovery
• Containment using surface and vertical barrier walls</td></tr>
<tr><td><u>Alternative GW-9A</u>
Removal using Existing System Groundwater Extraction System</td><td rowspan="2">• Continue to operate EW-4 as down gradient barrier well for shallow groundwater contamination in filled ravine.
• Continue to operate existing treatment system.</td><td>• No groundwater extracted from Kreher Park.</td><td>• Continue to operate EW-1, EW-2, and EW-3.</td><td>• Monitored natural attenuation
• Institutional controls
• Containment using surface and vertical barrier walls
• Ozone sparge
• Surfactant Injection</td></tr>
<tr><td><u>Alternative GW-9B</u>
Removal using Enhanced Groundwater Extraction System</td><td>• Install horizontal wells in saturated fill unit.
• Construct building at Kreher Park for groundwater treatment equipment.
• Treat contaminated groundwater on site</td><td>• Install additional extraction wells to recover contaminated groundwater and NAPL.
• Continue to operate EW-1, EW-2, and EW-3.
• Modify existing treatment system, and treat recovered fluid on site.</td><td>• Monitored natural attenuation
• Institutional controls
• Containment using surface and vertical barrier walls
• Ozone sparge
• Surfactant Injection
• Chemical oxidation
• Electrical resistance heating
• Dynamic underground stripping</td></tr>
</table>

7.4 Detailed Analysis of Retained Remedial Action Alternatives for Groundwater

Potential remedial alternatives for groundwater were evaluated in this section in accordance with the threshold criteria, primary balancing criteria, and modifying criteria described in Section 7.4.1 below.

7.4.1 Threshold Criteria

Threshold criteria, which relate to statutory requirements that each alternative must satisfy to be eligible for selection, include:

- Overall protection of human health and the environment
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs).

The "no action" alternative will not satisfy threshold criteria; it will not result in the protection of human health and the environment. Containment technologies (surface and vertical barriers) will prevent exposure to contaminants and prevent the off-site migration of contaminants with groundwater. The remaining potential remedial alternatives for groundwater will result in a reduction in mass, toxicity, and mobility of contaminants, which will result in the overall protection of human health and the environment.

The "no action" alternative will not achieve compliance with ARARs. However, the remaining potential remedial alternatives for groundwater will achieve compliance with ARARs as summarized in Table E-2 in Appendix E.

7.4.2 Balancing Criteria

The primary *balancing criteria*, which are the technical criteria upon which the detailed analysis is primarily based, include:

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost.

7.4.2.1 Long Term Effectiveness and Permanence

Each remedial alternative is evaluated as to magnitude of long-term residual risks, adequacy of controls, and reliability of long-term management controls in restoring soil contamination. Table 7-3 presents an evaluation of the long-term effectiveness and permanence of each alternative.

Table 7-3. Evaluation of Long-term Effectiveness and Permanence for Potential Groundwater Remedial Alternatives

<table>
<tr><th rowspan="2">Alternative</th><th colspan="3">Magnitude and Type of Residual Risk</th><th colspan="3">Adequacy and Reliability of Controls</th></tr>
<tr><th>Filled Ravine</th><th>Kreher Park</th><th>Copper Falls</th><th>Filled Ravine</th><th>Kreher Park</th><th>Copper Falls</th></tr>
<tr><td><u>Alternative GW-1</u>
No Action</td><td colspan="3">• Potential risk to human health or the environment, if any, would not be reduced.</td><td colspan="3">• There are no remedial actions or controls associated with this alternative.</td></tr>
<tr><td><u>Alternative GW-2A and GW-2B</u>
Containment Using Engineered Surface and Vertical Barriers</td><td colspan="2">• Contamination will remain in the contained area. Surface barriers will prevent direct contact with subsurface contamination, and vertical barriers will prevent off-site migration, which will reduce long-term potential risk to human health and the environment outside the contained area.
• Institutional controls could be implemented to prevent exposure to residual subsurface contamination in contained area</td><td>• Containment will not be effective for the Copper Falls; it will not reduce risk levels for this underlying aquifer.</td><td colspan="2">• Surface barriers would be effective at preventing exposure to subsurface contaminants, and vertical barriers would be reliable for preventing off-site migration for shallow groundwater, in the filled ravine and at Kreher Park.
• Long-term OM&M will be required to ensure containment ensure contaminants are not migrating from the contained area.</td><td>• Containment using surface or vertical barriers would not be reliable for underlying confined aquifer.</td></tr>
<tr><td><u>Alternative GW-3</u>
In-situ Treatment using Ozone Sparge</td><td colspan="3">• In-situ ozone sparge is used to degrade saturated zone contaminants in place; residual soil contamination may remain.
• Fill material may prevent or limit ozone injection and mixing.
• Institutional controls could be implemented to prevent exposure to residual subsurface contamination in contained area</td><td colspan="3">• Reliable technology for degrading dissolved phase contaminant mass in place.
• Can also be used to enhance recovery of NAPL via groundwater extraction.</td></tr>
<tr><td><u>Alternative GW-4</u>
In-situ Treatment using Surfactant Injection and Removal using Dual Phase Recovery</td><td colspan="2">• It may not be possible to inject surfactant into all areas, which could result in significant untreated residual contaminant mass remaining in place.</td><td>• Multiple surfactant injections may be required to remove NAPL.
• Institutional controls could be implemented to prevent exposure to residual subsurface contamination in contained area</td><td colspan="2">• Would not be adequate or reliable due to wide range of permeability of fill material.</td><td>• Surfactant injection would increase mobility of NAPL that could be removed by vacuum extraction and/or operation of groundwater extraction wells, which would reduce long-term OM&M.</td></tr>
</table>

Table 7-3. Evaluation of Long-term Effectiveness and Permanence for Potential Groundwater Remedial Alternatives

Alternative	Magnitude and Type of Residual Risk			Adequacy and Reliability of Controls		
	Filled Ravine	**Kreher Park**	**Copper Falls**	**Filled Ravine**	**Kreher Park**	**Copper Falls**
Alternative GW-5 In-situ Treatment using Permeable Reactive Barrier Walls	• Contamination will remain in the contained area. Surface barriers will prevent direct contact with subsurface contamination. Vertical barriers will prevent off-site migration, which will reduce long-term potential risk to human health and the environment outside the contained area. • PRB wall will be used to remove contaminants from groundwater discharging from contained area. • Institutional controls could be implemented to prevent exposure to residual subsurface contamination in contained area		• Containment will not be effective for the Copper Falls; it will not reduce risk levels for this underlying aquifer.	• Surface barriers would be effective at preventing exposure to subsurface contaminants, and vertical barriers would be reliable for preventing off-site migration for shallow groundwater, in the filled ravine and at Kreher Park. • Long-term monitoring will be required to ensure contaminants are removed from groundwater passing through the PRB wall.		• Containment using surface or vertical barriers would not be reliable for underlying confined aquifer.
Alternative GW-6 In-situ Treatment using Chemical Oxidation ***Alternative GW-7*** In-situ Treatment using Electrical Resistance Heating ***Alternative GW-8*** In-situ Treatment using Dynamic Underground Stripping (Steam Injection) ***Alternative GW-9A and GW-2B*** Removal using Groundwater Extraction	• Removal of significant volume of NAPL will reduce long-term potential risk to human health and the environment at the Site. • Site restoration will include surface barriers to prevent long-term exposure to shallow groundwater contamination. • Natural attenuation monitoring for shallow groundwater and deep groundwater in the underlying Copper Falls aquifer may be needed to evaluate on-going risk to human health and the environment.			• Would be effective for Copper Falls aquifer, and could also be used for shallow groundwater contamination • In-situ treatment could be completed in relatively short time frame, but long-term operation, maintenance, and monitoring will be required to ensure reliability of containment. • Institutional controls could be implemented to prevent long-term exposure to residual subsurface contamination. • Long-term operation, maintenance, and monitoring will be required to ensure reliability of containment. • Institutional controls could be implemented to prevent long-term exposure to residual subsurface contamination.		

7.4.2.2 Reduction of Toxicity, Mobility or Volume through Treatment

The remedial alternatives are evaluated for permanence and completeness of the remedial action in significantly reducing the toxicity, mobility, or volume of hazardous materials through treatment. Each alternative is evaluated based on the treatment processes used, the volume or amount and degree to which it destroys or treats hazardous materials; the expected reduction in toxicity, mobility, or volume provided by the alternative; the extent to which the treatment is irreversible; and the types and quantities of residuals that will remain following treatment. Table 7-4 presents a summary of this evaluation.

Table 7-4. Evaluation of Reduction of Toxicity, Mobility, or Volume through Treatment for Potential Groundwater Remedial Alternatives

Alternative	Treatment Process Used and Materials Treated	Volume of Material Destroyed or Treated	Degree of Expected Reductions	Degree to Which Treatment is Irreversible	Type and Quantity of Residuals Remaining
Alternative GW-1 No Action	None	None	None	Not applicable	Not applicable
Alternative GW-2A and GW-2B Containment using Engineered Surface and Vertical Barriers	No treatment prior to containment of shallow groundwater encountered in shallow fill unit at Kreher Park. Not feasible for Copper Falls aquifer.	No treatment but the fill unit at Kreher Park, which is approximately 10.5 acres in size, and is an average of 12 feet thick, will be contained. No treatment for Copper Falls aquifer.	No reduction in contaminant mass, but containment will prevent off-site migration of and exposure to shallow soil and groundwater. No reduction for Copper Falls aquifer.	No treatment. Contained fill at Kreher Park will remain on site. Will not influence implementation of any remedial alternative for Copper Falls.	All fill material, including the wood waste layer and contaminated soil in the former coal tar dump area would remain on site within the contained area. Does not address contamination in Copper Falls aquifer.
Alternative GW-3 In-situ Treatment using Ozone Sparge	Inject ozone to oxidize and destroy contaminants. Can also be used to displace NAPL for recovery via groundwater extraction.	Can be used to oxidize and destroy contaminants in shallow groundwater plume in upper bluff area and Kreher Park, and for underlying Copper Falls aquifer.	Can reduce dissolved phase contamination concentrations by 50 to 75%. Can also enhance NAPL recovery.	Ozone sparge is a chemical oxidation reaction, and is irreversible.	Ozone sparge is a chemical oxidation process that degrades contaminant to CO_2 and H_2O end product
Alternative GW-4 In-situ Treatment using Surfactant Injection and Removal using Dual Phase Recovery	Injection of a surfactant to enhance NAPL removal by vacuum enhanced recovery.	Surfactant injection is intended to enhance removal of NAPL.	Significant removal of NAPL can be expected, but multiple applications may be needed.	Removal of NAPL is irreversible. Surfactant is removed concurrent with NAPL; no lasting impacts from surfactant injection.	Not intended for dissolved phase contamination, but removal of NAPL will remove source of dissolved phase contamination.
Alternative GW-5 In-situ Treatment using Permeable Reactive Barrier Walls	Install a PRB wall to treat dissolved phase contaminants in shallow aquifer by adsorption onto GAC material used to construct PRB as groundwater passes through it. Not feasible for Copper Falls aquifer.	Contaminants from contained area at Kreher Park are treated as they pass through the wall. No treatment for Copper Falls aquifer.	Significant reduction of dissolved phase contaminants passing through PRB wall from confined area at Kreher Park can be expected. No reduction for Copper Falls aquifer	Removal of contaminants from groundwater will be irreversible, but contained fill at Kreher Park will remain on site. Will not influence implementation of any remedial alternative for Copper Falls.	All fill material, including the wood waste layer and contaminated soil in the former coal tar dump area would remain on site within the contained area. Does not address contamination in Copper Falls aquifer.
Alternative GW-6	Inject liquid reagent to	Can be used for shallow	Significant reduction in	Chemical oxidation is an	Chemical oxidation destroys

Table 7-4. Evaluation of Reduction of Toxicity, Mobility, or Volume through Treatment for Potential Groundwater Remedial Alternatives

Alternative	Treatment Process Used and Materials Treated	Volume of Material Destroyed or Treated	Degree of Expected Reductions	Degree to Which Treatment is Irreversible	Type and Quantity of Residuals Remaining
In-situ Treatment using Chemical Oxidation	oxidize and destroy contaminants. Can also be used to increase mobility and displace NAPL that could be recovered by groundwater extraction.	groundwater plume in upper bluff area and Kreher Park, and for underlying Copper Falls aquifer.	dissolved phase contamination, and increase in the mobility of NAPL can be expected.	irreversible reaction, but it can result in a permanent change to the aqueous geochemistry of the aquifer.	contaminant to CO_2 and H_2O end products by chemical oxidation.
<u>Alternative GW-7</u> In-situ Treatment using Electrical Resistance Heating (ERH)	Install electrodes in contaminated zone to heat aquifer to decrease viscosity and increase solubility and mobility of NAPL that is recovered by groundwater extraction or soil vapor extraction.	Can be used for shallow groundwater plume in upper bluff area and Kreher Park, and for underlying Copper Falls aquifer.	Significant removal of mobile and immobile NAPL and dissolved phase contaminants can be expected.	ERH is a thermal treatment process that increases mobility of NAPL; no lasting impacts from thermal treatment.	Removal of NAPL will remove source for dissolved phase contamination.
<u>Alternative GW-8</u> In-situ Treatment using Dynamic Underground Stripping (DUS) / Steam Injection	Inject steam into contaminated zone to heat aquifer and increase solubility and mobility of NAPL that is recovered by groundwater or soil vapor extraction.	Can be used for shallow groundwater plume in upper bluff area and Kreher Park, and for underlying Copper Falls aquifer.	Significant removal of mobile and immobile NAPL and dissolved phase contaminants can be expected.	DUS / steam injection is a thermal treatment process that increases mobility of NAPL; no lasting impacts from thermal treatment.	Removal of NAPL will remove source for dissolved phase contamination.
<u>Alternative GW-9A and GW-9B</u> Removal using Groundwater Extraction	Utilizes groundwater as a carrier to remove NAPL and dissolved phase contaminants.	Can be used for shallow groundwater plume in upper bluff area and Kreher Park, and for underlying Copper Falls aquifer.	Significant removal of mobile NAPL and dissolved phase contaminants can be expected over an extended period of time.	Treatment of extracted groundwater will be irreversible.	Will removed mobile NAPL, but immobile NAPL may also be removed as source for dissolved phase contamination.

7.4.2.3 Short Term Effectiveness

The evaluation of short-term effectiveness is based on the degree of protectiveness of human health achieved during construction and implementation of the remedy. Potential implementation risks to the community and site workers and mitigation measures for addressing those risks are included in this evaluation. In addition, environmental impacts during implementation and the time required to achieve the RAOs must also be considered in the evaluation of this criterion. Table 7-5 summarizes the results of this evaluation.

Table 7-5. Evaluation of Short Term Effectiveness for Potential Groundwater Remedial Alternatives

Alternative	Protection of Community and Workers During Remediation	Environmental Impacts of Remedy	Time Until RAOs are Achieved
Alternative GW-1 No Action	None	No additional impact to the environment	RAOs will not be achieved.
Alternative GW-2A and GW-2B Containment Using Engineered Surface and Vertical Barriers	Actions to protect community during remediation will include restricted access to work areas to prevent direct contact, and perimeter monitoring to ensure airborne contaminants are not migrating from the work area. Action to protect site workers during remediation will include the use of earth moving equipment to handle contaminated soil in exclusion zones, personnel protection equipment for workers, and work zone monitoring for airborne contaminants.	All fill material will remain at Kreher Park along with fill material at upper bluff area, but containment will prevent contaminant migration from contained area. No impact to Copper Falls aquifer.	Containment construction can be completed in short time frame. Post remediation monitoring for residual contamination remaining on site may be needed to ensure compliance with RAOs. Long-term operation, maintenance, and monitoring will be needed for Kreher Park.
Alternative GW-3 In-situ Treatment using Ozone Sparge		Will reduce dissolved phase contaminant concentrations and enhance NAPL removal in shallow and deep plumes.	In-situ treatment can be completed in short time frame. Post remediation monitoring for residual contamination remaining on site may be needed to ensure compliance with RAOs
Alternative GW-4 In-situ Treatment using Surfactant Injection and Removal using Dual Phase Recovery		Will enhance NAPL removal.	
Alternative GW-5 In-situ Treatment using Permeable Reactive Barrier Walls		All fill material will remain at Kreher Park along with fill material at upper bluff area, but PRB will prevent contaminant migration from contained area. NAPL will impact performance of the PRB. No impact to Copper Falls aquifer	
Alternative GW-6 In-situ Treatment using Chemical Oxidation		Will reduce dissolved phase contaminant concentrations and enhance NAPL removal in shallow and deep plumes.	
Alternative GW-7 In-situ Treatment using Electrical Resistance Heating			
Alternative GW-8 In-situ Treatment using Dynamic Underground Stripping (Steam Injection)			
Alternative GW-9A and GW-9B Removal using Groundwater Extraction		Will remove dissolved phase and NAPL contaminants and prevent off-site migration of contaminants with groundwater.	Long-term operation, maintenance, and monitoring of groundwater extraction system will be required Monitoring will be used to ensure compliance with RAOs

7.4.2.4 Implementability

Implementability is based on the evaluation of technical feasibility, administrative feasibility, and the availability of services and materials. Technical feasibility considers the following factors:

- difficulties that may be inherent during construction and operation of the remedy;
- the reliability of the remedial processes involved;
- the flexibility to take additional remedial actions, if needed;
- the ability to monitor the effectiveness of the remedy;
- the availability of offsite treatment, storage, and disposal facilities; and,
- the availability of needed equipment and specialists.

Administrative feasibility considers permitting and regulatory approval and coordination with other agencies. Table 7-6 presents a summary of this evaluation.

Table 7-6. Evaluation of Implementability for Potential Groundwater Remedial Alternatives

Alternative	Technical Feasibility	Reliability of Technology	Administrative Feasibility	Availability of Services and Materials
Alternative GW-1 No Action	Additional remedial actions could be easily implemented. No other relevant technical issues.	Not applicable.	No permitting required, but will likely not be able to obtain regulatory approval.	None required.
Alternative GW-2A and GW-2B Containment Using Engineered Surface and Vertical Barriers	Well suited for Kreher Park Miller Creek formation is shallow; not suited for confined Copper Falls aquifer. Wood waste layer may result in minor installation problems. Unlikely that additional remedial action for shallow groundwater will be required.	Containment is a reliable Containment technology will prevent exposure and contaminant migrations via shallow groundwater.	Regulatory agency and community approval likely.	Specialized and conventional equipment and materials required are commercially available.
Alternative GW-3 In-situ Treatment using Ozone Sparge	Installation of sparge wells may be difficult in shallow groundwater areas due to buried structures and wood waste layer. Groundwater extraction would be needed if used to enhance NAPL recovery.	Reliable technology for dissolved phase contamination. Can also be used to enhance NAPL recovery.	Minimal permitting requirements. Regulatory agency approval likely.	Convention drilling and trenching equipment will be used. Would require specialized equipment that is commercially available.
Alternative GW-4 In-situ Treatment using Surfactant Injection and Removal using Dual Phase Recovery	Buried structures and wood waste may prevent installation of sparge points. Groundwater extraction would be needed if used to enhance NAPL recovery.	Reliable technology for enhanced NAPL recovery.	Will require permit for injection. Regulatory approval likely.	Convention drilling equipment and vacuum truck will be used. Will use commercially available surfactant.
Alternative GW-5 In-situ Treatment using Permeable Reactive Barrier Walls	Well suited for Kreher Park Miller Creek formation is shallow; not suited for confined Copper Falls aquifer. Wood waste layer may result in minor installation problems. Unlikely that additional remedial action for shallow groundwater will be required.	Reliable passive system, but will require long-term monitoring to evaluate effectiveness.	Regulatory agency and community approval will be required for construction. Regulatory approval likely.	Conventional construction equipment would be used. Material used to construct the PRB wall is commercially available.
Alternative GW-6 In-situ Treatment using Chemical Oxidation	Injection into areas with buried structures and wood waste may be difficult in shallow groundwater. Groundwater extraction would be needed if used to enhance NAPL recovery.	Reliable technology for dissolved phase contamination, and can be used to enhance NAPL recovery.	Will require permit for injection. Regulatory agency approval likely.	Conventional drilling equipment used for injection Would use commercially available oxidizers.

Table 7-6. Evaluation of Implementability for Potential Groundwater Remedial Alternatives

Alternative	Technical Feasibility	Reliability of Technology	Administrative Feasibility	Availability of Services and Materials
Alternative GW-7 In-situ Treatment using Electrical Resistance Heating	Installation of wells or electrodes may be difficult in shallow groundwater areas due to buried structures and wood waste layer. Groundwater extraction would be needed if used to enhance NAPL recovery.	Reliable technology to enhance NAPL recovery.	Minimal permitting requirements. Regulatory agency approval likely.	Highly specialized equipment available through vendors specializing in application of remedial technology.
Alternative GW-8 In-situ Treatment using Dynamic Underground Stripping (Steam Injection)			Will require permit for injection. Regulatory approval likely.	
Alternative GW-9A and GW-9B Removal using Groundwater Extraction	Installation of wells may be difficult in shallow groundwater areas due to buried structures and wood waste layer. Can be easily used in combination with containment and several in-situ treatment technologies.	Reliable technology, but must be operated for an extended period of time.	Minimal permitting requirements. Regulatory agency approval likely.	Conventional drilling and trenching equipment will be used. Treatment equipment is commercially available.

7.4.2.5 Cost

Estimated costs for potential groundwater remedial alternatives include estimated capital costs for site preparation, implementation, and site restoration. Estimated costs for mobilization/demobilization, engineering, construction oversight, and contingency costs are estimated at 5, 15, 15, and 20-percent of capital costs, respectively. Annual operation, maintenance, and monitoring (OM&M) costs are estimated for each alternative. Additionally it is assumed that all work is contracted and the estimates do not account for possible economies of scale (i.e., completing all activities at the site concurrently). These cost estimates are developed primarily for the purpose of comparing remedial alternatives and not for establishing project budgets. A summary of potential groundwater remedial alternatives for groundwater is included in Table 7-7. The details of these costs are presented in Appendix F2 Tables F2-1 through F2-12

Table 7-7. Evaluation of Cost for Potential Soil Remedial Alternatives

Alternative	Area of Concern	Capital Costs	Mob/Demob	Engineering	Construction Oversight	Contingency	Post Construction OM&M	Total
Alternative GW-1 No Action	$0	$0	$0	$0	$0	$0	$0	$0
Alternative GW-2A Containment Using Engineered Surface and Vertical Barriers	Filled Ravine	$105,556	$5,278	$15,833	$15,833	$21,111	$0	$163,611
	Kreher Park	$4,237,768	$211,888	$635,665	$635,665	$847,554	$2,504,757	$9,073,298
Alternative GW-2B Containment Using Engineered Surface and Vertical Barriers	Filled Ravine	$105,556	$5,278	$15,833	$15,833	$21,111	$0	$163,611
	Kreher Park	$6,030,852	$301,543	$904,628	$904,628	$1,206,170	$1,469,226	$10,817,047
Alternative GW-3 In-situ Treatment using Ozone Sparge	Copper Falls	$763,000	$38,150	$114,450	$114,450	$152,600	$694,704	$1,877,354
	Filled Ravine	$133,000	$6,650	$19,950	$19,950	$26,600	$63,550	$269,700
	Kreher Park	$1,009,000	$50,450	$151,350	$151,350	$201,800	$84,050	$1,648,000
Alternative GW-4 In-situ Treatment using Surfactant Injection and Removal using Dual Phase Recovery	Copper Falls	$479,800	$23,990	$71,970	$71,970	$95,960	$682,404	$1,426,094
Alternative GW-5 In-situ Treatment using Permeable Reactive Barrier Walls	Filled Ravine	$105,556	$5,278	$15,833	$15,833	$21,111	$0	$163,611
	Kreher Park	$3,650,174	$182,509	$547,526	$547,526	$730,035	$397,088	$6,054,858
Alternative GW-6 In-situ Treatment using Chemical Oxidation	Copper Falls	$2,017,500	$100,875	$302,625	$302,625	$403,500	$2,596,420	$5,723,545
	Filled Ravine	$1,333,333	$66,667	$200,000	$200,000	$266,667	$67,363	$2,134,029
	Kreher Park	$1,352,389	$67,619	$202,858	$202,858	$270,478	$94,308	$2,190,510
Alternative GW-7 In-situ Treatment using Electrical Resistance Heating	Copper Falls	$4,439,200	$221,960	$665,880	$665,880	$887,840	$123,000	$7,003,760
	Filled Ravine	$2,852,633	$142,632	$427,895	$427,895	$570,527	$51,250	$4,472,832
	Kreher Park	$2,949,628	$147,481	$442,444	$442,444	$589,926	$71,750	$4,643,673
Alternative GW-8 In-situ Treatment using Dynamic Underground Stripping (Steam Injection)	Copper Falls	$4,637,200	$231,860	$695,580	$695,580	$927,440	$123,000	$7,310,660
	Filled Ravine	$1,698,333	$84,917	$254,750	$254,750	$339,667	$51,250	$2,683,667
	Kreher Park	$1,581,111	$79,056	$237,167	$237,167	$316,222	$71,750	$2,522,472
Alternative GW-9A Existing Groundwater Extraction System	Filled Ravine	$0	$0	$0	$0	$0	$2,220,466	$2,220,466
	Copper Falls	$105,556	$5,278	$15,833	$15,833	$21,111	$0	$163,611
Alternative GW-9B Enhanced Groundwater Extraction System	Copper Falls	$284,500	$14,225	$42,675	$42,675	$56,900	$5,978,656	$6,419,631
	Filled Ravine	$105,556	$5,278	$15,833	$15,833	$21,111	$0	$163,611
	Kreher Park	$966,278	$48,314	$144,942	$144,942	$193,256	$17,392,454	$18,890,185

7.4.3 Modifying Criteria

The third group, the *modifying criteria*, includes:

- State/Support agency acceptance
- Community acceptance.

As previously discussed, these last two criteria are typically formally evaluated following the public comment period, although they can be factored into the identification of the preferred alternative to the extent practicable. With regard to community acceptance criterion, it should be noted that the agencies conducted an outreach session consisting of a "community workshop" in Ashland on October 25, 2007. A summary of that workshop prepared by USEPA is included in Appendix C.

7.5 Comparative Analysis of Retained Remedial Alternatives for Groundwater

In this section, as required by CERCLA and NCP regulations, the alternatives will undergo a comparative evaluation wherein the advantages and disadvantages of the alternatives will be concurrently assessed with respect to each criterion. The criteria considered as part of this comparative evaluation are defined in Section 7.2. Table 7-8 presents a summary of the comparative analysis.

Table 7-8 – Comparison of Potential Groundwater Remedial Alternatives

Criteria	Alt. GW-1	Alt. GW-2	Alt. GW-3	Alt. GW-4	Alt. GW-5	Alt. GW-6	Alt. GW-7	Alt. GW-8	Alt. GW-9
	No Action	Containment using Surface and Vertical Barriers	In-situ Treatment using Ozone Sparge	In-situ Treatment using Surfactant Injection	In-situ Treatment using Permeable Reactive Barrier Walls	In-situ Treatment using Chemical Oxidation	In-situ Treatment using Electrical Resistance Heating	In-situ Treatment using Dynamic Underground Stripping/Steam Injection	Removal using Groundwater Extraction Wells
Overall Protection of Human Health and the Environment	None	Moderate	Moderate	High	Moderate	High	High	High	Moderate
Compliance with ARARs and TBCs	None	High	High	High	High	High	High	High	High
Long-term Effectiveness and Permanence	None	Low	High	High	Low	High	High	High	Moderate
Reduction of Toxicity, Mobility and Volume through Treatment	None	Moderate	Low	Moderate	Moderate	High	High	High	Moderate
Short-term Effectiveness	None	Very High	High	High	High	High	High	High	High
Implementability	None	Very High	High	High	Very High	High	High	High	High
Cost	None	Very High	Low	Low	Very High	High	Very High	High	Low
Agency Acceptance	None	High	High	High	High	High	High	High	High
Community Acceptance	None	Moderate	High	High	High	High	High	High	High

7.5.1 Overall Protection of Human Health and the Environment

Alternative GW-1 (no action) offers no additional human health and the environment because no additional actions would be taken to address groundwater contamination at the Site. ***Alternatives GW-2*** and ***GW-5*** (containment using surface and vertical barriers and in-situ treatment using PRB walls) offer an overall moderate level of protection because contaminants will be left on site. These materials will be contained and inaccessible to humans or biota, thereby reducing risk, but offer no protection for the underlying Copper Falls aquifer. ***Alternative GW-9*** (removal using groundwater extraction wells) can be used for shallow and deep groundwater, but offers a moderate level of protection of human health and the environment in the long-term because operation will require an extended period to achieve RAOs. The remaining alternatives offer high levels of protection because each technology will result in the removal of a significant contaminant mass, NAPL in particular, from the subsurface.

7.5.2 Compliance with ARARs and TBCs

Alternative GW-1 (no action) will not achieve compliance with ARARs and TBCs. Compliance with ARARs and TBCs could be achieved for the remaining remedial alternatives for groundwater. Implementation will require that engineering and construction actions be developed and completed in compliance with federal and state regulations.

7.5.3 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence considers long-term residual risks, adequacy of controls, and reliability of long-term management controls in restoring soil contamination. ***Alternative GW-1*** (no action) will not provide any long-term benefit; no additional actions will be taken to address groundwater contamination at the Site. ***Alternatives GW-2*** and ***GW-5*** (containment using surface and vertical barriers and in-situ treatment using PRB walls) offer low levels of effectiveness and permanence over the long term. Although risk will be reduced by containment of contaminated material, contaminants will be left on site. Additionally, both are limited to shallow groundwater; neither is feasible alternative for the underlying Copper Falls aquifer. ***Alternative GW-9*** (removal using groundwater extraction wells) will provide a moderate level of effectiveness and permanence over the long term; operation will be required for an extended period to achieve RAOs. The remaining alternatives have high levels of effectiveness and permanence over the long term because each technology will result in the removal of a significant contaminant mass, NAPL in particular, from the subsurface.

7.5.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Reduction of toxicity, mobility, or volume of hazardous materials through treatment considers the treatment processes used, the volume or amount and degree to which it destroys or treats hazardous materials; the expected reduction in toxicity, mobility, or volume provided by the alternative; the extent to which the treatment is irreversible; and the types and quantities of residuals that will remain following treatment. ***Alternative GW-1*** (no action) will not result in a reduction in the toxicity, mobility, or volume of contaminated groundwater. ***Alternatives GW-2*** and ***GW-5*** (containment using surface and vertical barriers and in-situ treatment using PRB walls) will not result in the toxicity or volume of contaminant mass. However, both will reduce contaminant mobility for shallow groundwater, but not for the Copper Falls. ***Alternative GW-9*** (removal using groundwater extraction wells) will result in a reduction in the toxicity, mobility, and volume of contaminant mass, but operation will be required for an extended period to achieve RAOs. Implementation of the remaining in-situ treatment alternatives will result in the highest degree of reduction of toxicity, mobility, and volume of impacted groundwater. However, amount of volume reduction will vary for each of the remaining in-situ treatment alternatives.

7.5.5 Short-term Effectiveness

Short-term effectiveness considers potential implementation risks to the community and site workers, environmental impacts, and time required to achieve RAOs. Implementation of ***Alternative GW-1*** (no action) will not achieve RAOs or improve environmental impacts in the short-term, but it will pose any implementation risks to the community and workers during remediation. The short-term effectiveness for the remaining alternatives is considered high. Each alternative can achieve RAOs and will reduce environmental impacts in the short-term by removing contaminant mass or preventing the off-site migration of contaminants. Containment, in-situ, and removal technologies evaluated in this report will require minimal effort to protect the community and workers during remediation.

7.5.6 Implementability

Implementability considers technical feasibility, administrative feasibility, and the availability of services and materials. ***Alternative GW-1*** (no action) will require the least amount of effort for implementability. Additionally, because no remedial action will occur, there would be no difficulty in implementing additional remedial actions at a later date. ***Alternatives GW-2*** and ***GW-5*** (containment using surface and vertical barriers and in-situ treatment using PRB walls) have a very high degree of implementability. The remaining alternatives have a high degree of implementability. However, buried structures in the upper bluff area and the wood waste layer at Kreher Park may limit the effectiveness of in-situ treatment for shallow and deep groundwater in these areas. Removal of the buried structures concurrent with remedial alternatives evaluated for soil in Section 6.0 may ease implementation of the in-situ treatment and removal alternatives for the Copper Falls. If removal and disposal (on- or off site) or on-site treatment is selected as a remedial response for soil, or if containment is selected for shallow groundwater, in-situ treatment and or removal will not be necessary for soil and shallow groundwater contamination, but one or more of the in-situ or removal technologies evaluated in this report will be required for the Copper Falls aquifer.

7.5.7 Cost

Preliminary cost estimates for potential remedial alternatives for groundwater include site preparation, implementation of the remedial response, and site restoration. There are no costs associated with ***Alternative GW-1*** (no action) because none of these activities will be completed. For shallow groundwater, ***Alternatives GW-2*** and ***GW-5*** (containment using surface and vertical barriers and in-situ treatment using PRB walls) have high installation costs. Annual OM&M cost for ***GW-2*** are high due to long term groundwater recovery and disposal costs, but low for ***GW-5***, which relies on in-situ treatment. Cost for implementation of the in-situ treatment ***Alternatives GW-6*** (chemical oxidation), ***GW-7*** (ERH), and ***GW-8*** (steam injection) area also high with low annual OM&M costs[25]. ***Alternatives GW-3*** (ozone sparging) has low implementation and annual OM&M costs. Implementation costs for ***Alternatives GW-9*** are the lowest, but have high annual OM&M cost for continued operation, which may be required for an extended period of time.

For the Copper Falls aquifer, in-situ treatment ***Alternatives GW-6*** (chemical oxidation), ***GW-7*** (ERH), and ***GW-8*** (steam injection) implementation costs area high. ***GW-6*** has high OM&M cost, and ***GW-7*** and ***GW-8*** have low OM&M annual costs. In-situ treatment ***Alternatives GW-3*** (ozone sparging), and ***GW-4*** (surfactant injection) implementation costs area low, but have high annual OM&M costs. As with shallow groundwater, implementation costs for ***Alternatives GW-9*** are the lowest, but have high annual OM&M cost for continued operation, which may be required for an extended period of time.

7.5.8 Summary

Groundwater remedial alternatives evaluated in this report include no action, containment, in-situ treatment, and removal technologies identified in the Alternative Screening Technical Memorandum (URS, revised May 2007). No Action (***Alternative GW-1***) was also retained as required by the NCP as a basis for comparing the other alternatives. Containment alternatives include ***Alternatives GW-2*** (containment using surface and vertical barriers) and ***Alternatives GW-5 (***in-situ treatment using PRB walls). If implemented, ***Alternatives GW-5*** would be used with ***Alternatives GW-2*** to minimize long-term treatment of shallow groundwater. The remaining in-situ treatment alternatives include the following:

- ***Alternative GW-3*** - In-situ Treatment using Ozone Sparge;
- ***Alternative GW-4-*** In-situ Treatment using Surfactant Injection and Removal using Dual Phase Recovery;
- ***Alternative GW-6*** - In-situ Treatment using Chemical Oxidation;
- ***Alternative GW-7*** - In-situ Treatment using Electrical Resistance Heating; and,
- ***Alternative GW-8*** - In-situ Treatment using Dynamic Underground Stripping /Steam Injection.

[25] These in-situ remedial alternatives are limited to the coal tar dump area. Significantly higher costs would be expected if implemented for all of Kreher Park.

Removal technologies evaluated for groundwater include dual phase recovery and removal using extraction wells. Dual phase recovery was evaluated with ***Alternative GW-4*** (in-situ treatment using surfactant injection) and removal using groundwater extraction wells (***Alternative GW-9)*** was evaluated as a stand alone remedial technology. However, all in-situ remedial technologies evaluated may require groundwater extraction is some capacity.

Containment is not a feasible remedial alternative for the underlying Copper Falls aquifer. The remaining groundwater remedial alternatives could be used for shallow groundwater in the upper area and Kreher Park and for the Copper Falls aquifer. Buried structures in the upper bluff area and the wood waste layer at Kreher Park may limit the effectiveness of in-situ treatment in these areas. If removal and disposal (on or off-site) or on-site treatment is selected as a remedial response for soil, or if containment is selected for shallow groundwater, in-situ treatment and or removal will not be necessary for soil and shallow groundwater contamination. However, one or more of the in-situ or removal technologies evaluated in this report will be required for the Copper Falls aquifer.

8.0 Development and Evaluation of Remedial Action Alternatives – Sediment

8.1 Remediation Action Objectives for Sediment

As described in the RAO Technical Memorandum (Appendix A to the Remedial Investigation; URS 2007b), in general, the goals of remedial action for sediment are to prevent human ingestion or direct contact with sediments having COPCs which pose an unacceptable risk to human health. Similarly, for ecological receptors, the general goal is to prevent direct contact with or ingestion of sediments or of prey having levels of COPCs that would pose an unacceptable risk to populations of ecological receptors or individuals of protected species.

Remedial action objectives for sediment include:

- Protect human health by eliminating exposure (direct contact, ingestion, inhalation, fish ingestion) to sediment with COPCs in excess of regulatory or risk-based standards;
- Conduct NAPL removal whenever it is necessary to halt or contain the discharge of a hazardous substance or to minimize the harmful effects of the discharge to the air, land or water; and
- Protect populations of ecological receptors or individuals of protected species by eliminating exposure (direct contact with sediment or ingestion of sediment or prey) to sediment with COPCs that would pose an unacceptable risk.

With the exception of iron, the cumulative risks estimated for the human health recreational receptor exposures to sediments were below EPA's target risk levels.

For ecological receptors, USEPA set the sediment PRG at 2295 μg PAHs/g Organic Carbon (OC) or 9.5 ug PAH/g dwt at 0.415% OC based upon their "best professional judgment". In addition, USEPA directed that, "i<u>f the final depth of sediments will be less than 6 feet, </u>the PRG for any active remedial intervention will be adjusted downward as based upon ultraviolet light (UV) extinction coefficients measured in Site waters. In addition, sediments in greater than 6 feet of water having a concentration equal or less than 2,295 ug PAH/g OC (9.5 ug PAH/g dwt at 0.415% OC) and sediments in 6 feet or less of water having a concentration greater than a UV-adjusted PRG will be monitored to assure that there are no unacceptable impacts to benthic community and that the levels of PAHs in surface sediments decrease over time to 1340 ug PAH/g OC (5.6 ug PAH/g dwt at 0.415% OC)."

8.2 Screening of Remedial Action Alternatives – Sediment

8.2.1 Chemicals of Potential Concern – Sediment

The screening of sediment alternatives focuses on PAHs as the primary COPC. VOCs and metals are also COPCs but the PRG is based on PAHs because PAHs are the "risk-drivers" and VOCs and metals co-exist with the PAHs.

8.2.2 Screening of Remedial Alternatives – Sediment

General response actions, technologies and process options for sediment are summarized in Table 8-1. Those retained after the Alternatives Screening Technical Memorandum (see Appendix A1) are shown in bold in Table 8-1.

Table 8-1 - Summary of Sediment Technologies Reviewed
(Partially Adapted from the Lower Fox River Feasibility Study - ThermoRetec 1999)
(Alternatives in bold are retained)

General Response Action	Remedial Technology	Process Options
No Action	**None**	**Not Applicable**
Institutional Controls	**Physical, engineering or legislative restrictions**	Consumption advisories **Access restrictions** Dredging moratorium
Natural Recovery	**Reduction of toxicity, volume or mobility of contaminant by naturally occurring biological, chemical or physical processes**	**Sedimentation** **Resuspension and transport** **Mixing**
Containment	**Subaqueous capping**	**Thin layer cap** **Sand cap** **Composite cap** Engineered materials (cement) cap **Armored cap**
	Confined Disposal Facility	**Sheet pile** **Combination of sheet pile and slurry wall** **Impervious cap** **Groundwater management**
Removal	**Dredging**	**Hydraulic dredging** **Mechanical dredging** **Barge-mounted backhoes or excavators**
	Excavation in the dry	**Excavator, sheetpiling, etc. for specific areas**
In-situ Treatment	Biological	*In-situ* slurry oxidation *In-situ* aerobic biodegradation *In-situ* anaerobic biodegradation
	Chemical	*In- situ* slurry oxidation Aqua MecTool oxidation *In-situ* oxidation Electrochemical oxidation
In-situ Treatment (Cont)	Physical Extractive process	Sediment flushing SVE/thermally enhanced SVE/bioventing Air sparge
	Physical-immobilization	Air sparge MecTool stabilization Vitrification Imbiber beads Ground freezing

Table 8-1 - Summary of Sediment Technologies Reviewed
(Partially Adapted from the Lower Fox River Feasibility Study - ThermoRetec 1999)
(Alternatives in bold are retained)

General Response Action	Remedial Technology	Process Options
Ex-situ Treatment	Biological	Land farming/composting Biopiler Fungal degradation Slurry phase biological treatment Enhanced biodegradation
	Chemical	Acid extraction Solvent extraction Slurry extraction Reduction/oxidation
	Chemical/Physical	Dehalogenation **Sediment washing** Radiolytic dechlorination
	Physical	**Separation** **Hydrocyclone** Solidification
	Thermal	**Incineration** **High temperature thermal desorption** **Low temperature thermal desorption** Pyrolysis High-pressure oxidation
Dewatering	**Mechanical**	Centrifugation **Belt press** **Filter press** Geobag
	Gravity	**Settling on-barge** **Settling dewatering impoundments** Solidification
Disposal	**On-site disposal**	Level bottom cap Confined aquatic disposal (CAD) **Confined disposal facility** Nearshore biofiltration cell **Upland confined fill** **Beneficial re-use**
	Off-site disposal	Dedicated new upland landfill **NR 500 landfill (county, private, industrial landfills)** **Upland confined fill (commercial/industrial)** **Upland fill (residential/clean)**

8.3 Development of Potential Remedial Alternatives for Sediment

Remedial technologies retained for screening were used to develop potential remedial alternatives for sediment. A summary of each remedial alternative follows. A detailed description of each alternative can be found in the Comparative Analysis Technical Memorandum (URS 2007c).

8.3.1 Alternative SED-1: No Action

The no-action alternative was retained as a baseline against which other technologies are compared. The no-action alternative assumes no cleanup or long-term monitoring, and is not expected to meet the RAOs. No action requires no planning, maintenance, or monitoring. Under this alternative, it is anticipated that natural mechanisms, such as dispersion, biodegradation, etc., would eventually reduce concentrations of VOC and PAH and NAPL; however, no monitoring would be performed to determine if these mechanisms are indeed taking place, nor would any method of evaluating potential risk to human health and the environment be enacted.

8.3.2 Alternative SED-2: Sediment Containment within a Confined Disposal Facility

8.3.2.1 Introduction

Alternative SED-2 would consist of sediment removal followed by disposal and containment within a CDF combined with institutional controls and monitored natural recovery. This alternative is illustrated in Figure 8-1 and consists of the following components:

1) Determine the area of sediment containing significant wood debris and NAPL material to be covered by and contained within a CDF (currently this is estimated to be about seven acres of lake bed);
2) Construct CDF around pre-determined sediment area as well as upland portions of the Site that are impacted by wood material mixed with coal tar wastes;
3) Remove sediment containing concentrations of PAH greater than 9.5 ug PAH/g dwt at 0.415% OC located outside the CDF footprint and place within CDF area;
4) Place any other impacted soils from upland areas into CDF; and
5) Monitor sediment areas outside of CDF where concentrations of PAH greater than 5.6 µg PAH/g dwt at 0.415% OC have been observed.

Equipment that may be used for implementation of this alternative includes:

- Dredging equipment – for removing sediment from the lakebed
    - Hydraulic
    - Mechanical
- Excavation/construction equipment – for construction of portions of the CDF and dewatering basins
    - Traditional
    - Long-stick

  - Barge equipped with crane, pile driving hammer
  - Barge equipped with crane and carriage lift for placement of stone and barges loaded with blasted rock/cut limestone
- Transportation equipment – for moving sediment from the dredge to the CDF
  - Barge
  - Piping
- Water treatment equipment
  - Piping to lake or WWTP for treatment of water and collected fluids,
  - Water treatment system
    - Oil/water separator
    - Sand filtration
    - Activated carbon adsorption
- Monitoring equipment – to evaluate effectiveness of remedy
  - Groundwater monitoring wells
  - Piezometers for water level measurements
  - Sediment sampling devices
  - Surface water sampling devices

This alternative was described in detail in the Comparative Analysis of Alternatives Technical Memorandum which is attached to this FS as Appendix A2. Attachment 3 to that technical memorandum provided information on the state of the practice on using CDFs for permanent storage of contaminated sediments. Some of that information is summarized again in the following sections.

8.3.2.2 Concept

A CDF alternative would meet the sediment PRGs at less cost than anticipated for some of the other alternatives. In addition to being a less expensive, virtually site-wide remedy, this alternative is designed to avoid the potential risks from volatilization of VOCs during debris removal and dredging and excavation of sediment and soil. The CDF would be designed to cover most the areas of the offshore sediment that are impacted by NAPL as well as areas with the most wood debris. Sediment with unacceptably elevated levels of SVOCs and VOCs, including NAPL, as well as areas in Kreher Park that are impacted by wood material mixed with coal tar wastes, would remain in place and be incorporated into the CDF.

The design of the CDF would be compatible with the recreational nature of the nearshore area and incorporate features that will enhance both recreational use of the area, including an expansion of the marina, as well as wildlife usage. Figures 8-2 and 8-3 illustrate this concept.

The CDF would be constructed over approximately seven acres of lake bed and 13 acres of upland. The elevation at the lake boundary will be approximately 609’ NGVD in order to prevent wave overtopping. This elevation was estimated using wave height analysis based upon a 100 year return wave height and period, using 100 year still water level and water depth and bottom slope (See Appendix G). This elevation will be confirmed during Remedial design. The top of the CDF would be fairly level, although there would be a provision for drainage and "blending" with upland topography.

As conceived, there would be open areas designed as grassland habitat and managed for wildlife, and other areas designed and managed for recreational use by the public, i.e., boaters, fishers, birdwatchers, etc. There would also be the option for the City of Ashland to incorporate elements of an expanded marina similar to those envisioned in the Ashland Waterfront Development Plan.

8.3.2.3 Rationale and Precedent

A comprehensive discussion on the use of CDFs for disposal of contaminated sediments and precedent for CDFs in the Great Lakes by Dr. Mike Palermo was originally provided in detail in the Comparative Analysis of Alternatives Technical Memorandum which is attached to this FS as Appendix A2. Attachment 3 to that memorandum provided information on the state of the practice on using CDFs for permanent disposal of contaminated sediments. CDFs are one of the most commonly considered alternatives for contaminated sediments from navigation projects and are also an option commonly considered and more recently used for disposal of contaminated sediments dredged for purposes of sediment remediation (USACE 2003, USEPA 2005).

Design of CDFs has evolved over the years based on research and field experience. CDFs have combined design features and processes common to wastewater treatment, landfills, dams, and breakwaters. The designs for existing CDFs in the Great Lakes have focused primarily on retention of sediment solids and physical stability of the dikes in the high-wave and ice-prone environment of the Great Lakes. In-water CDFs in the Great Lakes, (e.g., Duluth-Superior Harbor - Erie Pier) have dikes that resemble a breakwater made of stone, gravel and other materials. Large armour stones are typically placed on the outside face of the dike to protect against the erosive effects of waves and ice. The inner core of the dike is often constructed with sand and gravel, sometimes in discrete layers. The dike, which is initially permeable, encircles the disposal area where the dredged material is placed. The sediment particles and contaminants bound to the particles settle out in the disposal area and excess water passes back through the dike. As the facility becomes filled, the dikes become less permeable, and water must be removed by overflow weirs, filters in the dikes, or pumping. Upland CDFs are designed with earthen dikes that resemble a levee or berm. The dikes are most often constructed with soil excavated from the disposal site, and the sides seeded to prevent erosion (Miller 1998).

Development of a comprehensive technical basis for CDF design aspects related to management of contaminated sediments began in the mid-1970s with the USACE research programs initially authorized by the River and Harbor Act of 1970 (P.L.91-611). These efforts included evaluation of sedimentation and consolidation processes in CDFs; weir design; CDF effluent and leachate control; equipment and techniques for dewatering and reclamation; and beneficial reuse of material in CDFs. The first guidelines for designing, constructing, and managing (CDFs) to maximize service life and minimize adverse environmental impacts were developed (Palermo, Montgomery, and Poindexter 1978), and these guidelines were subsequently updated and expanded in the USACE Engineer Manual *Confined Disposal of Dredged Material* (USACE 1987).

USACE and USEPA subsequently developed a Technical Framework for dredged material management (USACE 2004) that included full consideration of CDF contaminant transport pathways and controls, and developed a supporting sediment testing manual that provided detailed testing and evaluation procedures for CDF contaminant pathways (USACE 2003). An expanded Engineer Manual *Dredging and Dredged Material Management* (USACE in publication) has also been developed that will include guidance on design of contaminant control measures for CDFs. Collectively, these developments have resulted in a comprehensive technical basis for design of CDFs used for placement of contaminated sediments resulting from both navigation and sediment remediation projects.

Field experience and the availability of technically-based design procedures for CDF contaminant pathway evaluations and controls has led to increased consideration and use of CDFs for a number of sediment remediation projects – over 40 have been constructed on the Great Lakes alone (USACE 2003). As a result, USEPA recognized CDFs as an option for disposal of contaminated sediments at CERCLA sites in its Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (USEPA 2005):

> "CDFs are engineered structures enclosed by dikes and specifically designed to contain sediment. CDFs have been widely used for navigational dredging projects and some combined navigational/environmental dredging projects but are less common for environmental dredging sites, due in part to siting considerations. However, they have been used to meet the needs of specific sites, as have other innovative in-water fill disposal options, for example, the filling of a previously used navigational waterway or slip to create new container terminal space (e.g., Hylebos Waterway cleanup and Sitcum Waterway cleanup in Tacoma, Washington). In some cases, new nearshore habitat has also been created as mitigation for the fill."

Table 1 in Attachment 3 to Appendix A2 summarizes the locations, and readily available information on volumes, surface areas, filling operations and contaminant control measures for a total of 29 CDFs used for placement of sediments from remediation projects. A large number of additional CDFs have been used for placement of contaminated sediments from navigation dredging projects (with a number of CDFs used for highly contaminated dredged sediments), but these CDFs were not included in the summary in Table 1 in Attachment 3 to Appendix A2. A total of 22 of the CDFs are in-water nearshore or island sites, with many constructed by enclosing berths, slips, or areas adjacent to other confining structures such as breakwaters. These include several CERCLA projects in the Seattle/Tacoma, WA area to include: Blair Waterway, Milwaukee Waterway, and Eagle Harbor CDFs. The Waukegan Harbor site in Illinois is a similar nearshore CERCLA CDF created by enclosing 3 acres of Lake Michigan waters by a sheet pile wall structure. The Menominee River site in Marinette WI is similar to the Waukegan Harbor site in that approximately two acres of contaminated sediment was enclosed by a sheet pile structure and capped.

As part of a project very similar in design to what is being proposed for the Ashland site, the Hamilton Harbor, Canada CDF will be constructed as a nearshore CDF for disposal of sediments contaminated with elevated levels of PAHs and NAPL from Hamilton Harbor, a project conducted under the Canadian Cleanup Fund (similar to the U.S. CERCLA program). Several other sites in Table 1 in Attachment 3 to Appendix A2 are placements of contaminated sediments from remediation projects in existing CDFs in the Great Lakes. These placements were made in dedicated cells constructed within the larger existing CDFs. In addition to the CDFs actually used for remediation placements to date, several large CDFs are now in the feasibility or design stages for large-scale CERCLA sediment remedies. These include the Onondaga Lake, NY upland CDF that would enclose a 160 acre site for placement of over 2.3 million cubic yards of contaminated sediment and two large nearshore CDFs: the Terminal 4 CDF site that would be created by enclosure of a 14 acre slip on the Willamette River near Portland, OR, and the Consolidated Slip CDF that would be created by enclosure of a 4 acre berthing area in the Port of Los Angeles. These precedent sites represent a range of sediment characteristics and site conditions and contribute to an ongoing and potentially increasing experience base for use of CDFs as sediment remedy alternatives, including construction of nearshore CDFs in coastal, riverine and lake environments.

8.3.2.4 Site-specific Elements of a CDF Design

There are several site-specific factors that will be considered during Remedial Design. These include the physical characteristics of the Site as well as the results of the Treatability Studies that were conducted in support of this FS (See Section 4.0 and Appendices B2, B3 and B4.

Site Characteristics

Based upon core logs the stratigraphy of the offshore area that will be the focus of remedial efforts consists of:

1. contaminated wood layer
2. sand layer: Miller Creek beach deposit
3. silt layer: Miller Creek silt deposit
4. clay layer: Miller Creek clay deposit
5. sand layer: Copper Falls formation.

The wood layer is generally thicker nearshore and therefore would be confined within the CDF footprint. Covering areas of the sediment where there is the most wood debris significantly reduces the amount of wood debris that will require removal, handling and disposing. Although the wood and sediment that would be underlying the CDF have different consolidation properties, based upon the Multiphase Testing (Appendix B4) this characteristic would not materially affect long term consolidation behavior of the CDF cap.

Since NAPL was observed in the wood layer and in the Miller Creek sand and silt layers, the potential for NAPL mobility within the CDF will be considered in Remedial Design using the results from the Multiphase Testing. In addition, collection and removal of NAPL during placement of dredge materials into the CDF will be addressed during Remedial Design.

The potential for transport of NAPL due to ebullition also will be evaluated during Remedial Design. Both the Cap Flux Test (Appendix B2) and the Multiphase Testing (Appendix B4) provided information on this transport mechanism.

The geotechnical capacity of Miller Creek clay layer also will have to be addressed during Remedial Design since it is anticipated that sheet piling will be keyed into this layer. More core sampling and analysis along the proposed wall location likely will be needed to support Remedial Design.

In addition, since several of these sediment layers potentially have elevated levels of VOCs, including benzene, naphthalene and methylnaphthalene, control of emissions from these sediments also will be evaluated during Remedial Design.

The CDF cap and sheet pile enclosure of the CDF also will include the area in Kreher Park. As a result groundwater flow characteristics up gradient of the CDF as well as the thickness of the Miller Creek clay formation will need to be considered in the design and placement of hydraulic controls and the sheet pile or slurry wall.

Implications of Treatability Studies

As discussed in Section 4.0 several treatability studies have been conducted to support remedial alternatives screening for sediment. The following sections briefly discuss the implications of these studies to the design and construction of the CDF.

Ebullition and Related NAPL Transport

Based upon the Cap Flux Test (Appendix B2) sediments at 20^{O} C and higher generated gas and test the rate of gas generation and ebullition increased with higher temperatures and over longer testing periods. However, the capped columns did not show that the NAPL was transported through the caps even after six months of testing. The practical result of this testing indicates that while it is unlikely NAPL transport via ebullition will be a problem at ambient Site temperatures it will be prudent to include a gas collection and relief system in design of the CDF cap as a precaution.

NAPL Mobility

Since the results of the Multiphase Testing (Appendix B4) indicated that there is insufficient flow from consolidation during initial capping to mobilize NAPL, there is little likelihood that NAPL will be collected in a cap dewatering drainage system.

Consolidation of Sediments

The results of the Multiphase Testing (Appendix B4) indicated that consolidation times are expected to be shorter than 17 days. This is much less time than will be required for dredging, dredge material deposition and CDF cap placement which is estimated to take about 180 days. Because of this it will not be necessary to split up the dredging and capping time into two years to accommodate consolidation.

Air Emissions

Bench scale air emissions testing (Appendix B3) was conducted to simulate VOC and odor emissions from various operations that would take place during this remedial alternative. Based upon results of this testing it was concluded that under some conditions VOCs potentially would be transported to locations where the public would be exposed to VOCs above relevant health criteria. As a result, engineering controls and response action plans will have to be developed as part of Remedial Design.

8.3.2.5 Implementation of Remedy

Mobilization/Demobilization

This includes mobilization and demobilization of all the equipment and facilities needed to implement this alternative. This is estimated to be 5% of the remedial costs.

Construction of CDF

As previously discussed the CDF would be constructed over approximately seven acres of lake bed and 13 acres of upland. The elevation of the CDF at the lake boundary will be approximately 609’ NGVD in order to prevent wave overtopping. Sealed sheet piling will be used to enclose the CDF and prevent contaminant migration. The method of sealing will be evaluated for water-side and soils areas during Remedial Design and it will be determined whether maintaining a lower gradient inside the containment areas is needed. It is expected that sheet piling will be utilized around the entire site although it is possible a slurry wall will be used in some upland areas, particularly where overburden is thin at the base of the bluff. A barge mounted pile driver will be used to drive pilings in the water. The CDF is intended to contain all of the sediment and groundwater in an essentially watertight enclosure. On the lake side of the wall a protective stone dike will be constructed against the sheet piling as a barrier to storms and ice movement. The extent of this armored dike will be determined in Remedial Design. Other considerations included in the construction cost estimate are placement and disposal of the hydrocarbon booms to collect NAPL that may be released during dredging and placement activities. This might include booms around the dredge where NAPL potentially may be released during dredging. Booms also will be deployed in CDF water areas until final capping activities are started.

Sediment Removal

Sediment removal under this alternative is less complex because a design objective for the CDF is that it will cover most of the areas that contain the majority of the wood debris and NAPL. This will avoid the need for substantial debris removal and with it the potential for release of VOCs and NAPL. Removal of sediment outside of the footprint of the CDF under this alternative likely will be accomplished with a hydraulic dredge. Although this will result in a need to treat more dredge water, hydraulic dredging will minimize volatilization and resuspension. Some modern hydraulic dredges should be able to achieve 20% solids content (v/v) with careful control when dredging in areas that are relatively debris-free.

Under this alternative, volatilization associated with dredging and dredge material dewatering may be an issue, but it expected to be less than for Alternatives SED-3, SED-4 and SED-5 since the areas that will be dredged have relatively low levels of contaminants.

Areas outside of the footprint of the CDF with concentrations of total PAHs greater than the sediment PRG of 9.5 µg PAH/g dwt at 0.415% OC will be dredged and pumped directly to the CDF. Under this scenario approximately 74,000 CY of sediment exceeding the PRG would be dredged from the approximately nine acre area outside of the CDF and disposed in the CDF. After dredging is completed, six inches of clean sediment would be placed on areas that are dredged. This would help in covering any dredging residuals as well as providing a better habitat for recruitment of benthic macroinvertebrates and for spawning of fish.

Performance Objectives for Dredging Residuals and Dredging-Related Resuspension

Dredging performance objectives will be developed for allowable rates of sediment resuspension during dredging based upon water quality standards that are protective of ecological receptors. These will be used for operational control of dredging. Typically, performance objectives for resuspension are two or three-tiered and specify how dredging operations need to be modified if the action levels are exceeded.

Dredging performance objectives also will specify goals for residual concentrations of contaminants in surface sediments for areas that have been dredged. Typical performance objectives for dredging residual would be based upon the comparison of surface-weighted average concentrations (SWAC) to the sediment PRG. These performance objectives would specify whether re-dredging is necessary and in some cases when a thin layer cap would be applied to meet performance objectives.

Volatilization and Odor Control

While volatilization is expected to be considerably less than for full scale dredging (Alternative SED-4), dry excavation (SED-5) or even Alternative SED-3, if volatiles are released, they may disperse beyond the immediate vicinity of dredging operations, within the CDF water areas and onshore treatment operations, depending upon ambient weather conditions (Appendix B3). With the proximity of a relatively large population in Ashland, this presents the real possibility of unacceptable exposure unless engineering controls are designed.

Controls for minimization of volatile releases are available for onshore operations; however, volatilization control for operations on the water would have to be investigated further during a pilot scale project, since tenting over working dredges on the water is difficult and would add complexity to maintaining efficient dredge production rates. Engineering controls for volatilization are discussed at greater length under the Alternative SED-4.

It is possible that remedial construction workers would have to wear Class C PPE.

Silt Curtains and Hydrocarbon Booms

Engineering controls for minimizing release and dispersal of dissolved or free phase contaminants to water beyond the Site while dredging are well developed and would likely consist of redundant turbidity barriers and booms. These turbidity barriers may be surrounded by modular wave dampening barriers if necessary. Temporary sheet piling will also be considered if redundant turbidity barriers and booms are not effective. This aspect of a dredging remedy can also be evaluated and optimized though a pilot scale project.

Again, this alternative will minimize the release and dispersal of dissolved or free phase contaminants to water beyond the Site since the CDF will cover the areas that have the highest levels of VOCs and NAPL.

Sediment Dewatering

Prior to dewatering, the dredge material will be processed to separate wood from sediment. This can be achieved through processes that separate sediment by screening, gravity settling, and floatation. Screening would likely take place on the dredge if the material is mechanically dredged and hydraulically transported to the CDF. No other dewatering will be needed except for dredge dewatering of the debris stockpile in the barge before placing debris in the dumpster for disposal. Dredging of the area outside the CDF will allow the sequential filling of several cells within the CDF while allowing the other cells to settle the suspended solids. From this settling area, the excess water will be drawn off for treatment and discharge back to the lake. Any NAPL that floats in the cells will be skimmed from the surface, run through an oil/water separator and contained for off-site disposal (Figure 8-1). Evaluation of these operations will be further detailed in Remedial Design and may require additional treatability testing.

Wastewater Treatment

Water treatment potentially would include addition of polymers and alum to help settle fine particles in the CDF. Testing will be needed to determine solids settling rates, and if necessary, the effects chemical aides have on consolidation. Water would be pumped off at a rate approximately equal to the sediment placement into the CDF within certain design limits for head differential across the sheet pile wall. The system would include pumping the clear water near the surface of the CDF to a bag or sand filter or other cartridge filters, an oil/water separator and through an activated carbon filter bed (Figure 8-1). The treated water meeting the substantial requirements of an NPDES permit would be discharged to Lake Superior or to the WWTP. The cost for water treatment also includes operating a skimmer in the CDF to control any floating NAPL.

As an alternative to direct placement of sediments in the CDF using hydraulic dredging, hydraulic transportation from mechanically dredged sediments also may be considered. This would include a screen on a hopper at the dredge that would discharge to a high solids slurry pump. Make-up water that is pumped from CDF after settling would be mixed with the sediments to a 15%-20% solids level and hydraulically conveyed in a pipe through a discharge nozzle into the CDF. This nozzle could be a tremy type design to minimize velocity at the discharge and also minimize suspension of fines in the CDF water. Use of a tremy also would allow more controlled placement and help reduce water settlement treatment in the CDF and may also help with preventing segregation of the dredged sediment placement and thus facilitate consistent consolidation. A cumulative estimated flow of about 40 million gallons will be re-circulated to the dredge using only settlement and polymer treatment in the CDF prior to pumping back to the dredge. A total of approximately 17 million gallons of wastewater resulting from sediment dewatering and the recirculating system will get fully treated and discharged to the lake or WWTP.

Ancillary Solid Wastes

Waste such as personal protective equipment (PPE), construction debris and other types of solid wastes generated during the conduct of remedial activities can be disposed at a local solid waste landfill. The quantity generated will depend on the remedial alternative. PPE will be evaluated and handled in accordance with USEPA guidance document to handle investigation derived waste (USEPA 2007).

CDF Closure

Closure of the CDF after all dredging is complete will include construction of a CDF cap over the entire contained area. The CDF cap will meet Chapter NR 504.07, WAC design and construction specifications. Cap construction will include placing a one to two-foot sand cap on the dredged sediments to begin the consolidation process as well as provide a support layer over the water area. According to the Multiphase Testing (Appendix B4) results, this consolidation will allow the release of the pore water and gas from ebullition to rise to the surface without any significant transport of the contaminants. Multiphase Testing (Appendix B4) predicts that should NAPL be present, it will not be mobilized.

The cap will be placed in one-half to one foot lifts to facilitate even consolidation. After sufficient consolidation, additional sand will be placed in areas that are lower due to differential settlement. Settlement characteristics will be further evaluated during Remedial Design and placement techniques, such as the use of a tremy, will be considered to optimize even settlement, A sand drainage layer is part of the initial sand support layer, followed by a two foot compacted clay layer underlying a 40 mil HDPE liner. Drainage wells or wicks will be used to facilitate removal of water produced from additional consolidation in the drainage layer below the HDPE liner. This lower drainage layer will be sloped to allow removal of any gas accumulation and vented at the drainage wells and will be further evaluated in design. Another geotextile drainage layer or 1 x 10^{-3} cm/sec hydraulic conductivity sandy soil will be added above the HDPE liner to collect the storm water seepage. A two and one half-foot compacted layer additional foot of fill (sand) of local soils for a drainage and plant rooting will be placed on top of the HDPE liner with an overlying layer 0.5 ft top soil that will be seeded for grass or planted with shrubbery. A conceptual cross section of the CDF cap is provided in Figure 8-4.

Long term performance and consolidation of the cap has been evaluated in the DECON Modeling and bench testing conducted during the Multiphase Testing (Appendix B4) and these results will be considered during Remedial Design. Drainage wells will be used to monitor moisture levels and used for removal of any additional water infiltration should this occur above acceptable levels over the long term. A plan view illustrating conceptual detail below the clay is provided in Figure 8-5. Since consolidation times of the sediments in the CDF are predicted to be rapid by the DELCON model (Appendix B4) consolidation pore water infiltration should be minimal within the CDF.

On the land side of this cap in Kreher Park, the cap will be designed to meet the same requirements of Chapter NR 504.07, WAC and will be vegetated or paved on top. Up gradient groundwater will be passively diverted around the CDF through use of drainage tiles and/or the use of the existing hydraulic control system for the Filled Ravine. A means to discharge water to storm drainage systems would be a part of the hydraulic control plan for the CDF. The CDF cap will also include plantings to enhance evapotranspiration and absorb drainage from the hillside and a drainage layer shown in Figure 8-6. This should minimize the volume of run-off water that needs to be collected.

Any plantings on the cap will comply with the revegetation requirements specified in the Chapter NR 504.07, WAC criteria unless otherwise approved by WDNR.

Wetland Mitigation

Interaction with WDNR would be needed to identify appropriate mitigation/restoration projects to compensate for permanent loss of shallow water lake bed. Appropriate projects might include wetlands/river restoration, granting access across NSPW property adjacent to rivers or conveyance of land that has relevant environmental value. For purposes of this FS Report evaluation we have included $1.5 million for compensatory restoration.

Monitoring

The magnitude and nature of monitoring will include the following:

- baseline monitoring;
- implementation monitoring;

- verification monitoring;
- operation and maintenance monitoring; and
- long-term monitoring to verify achievement of PRGs.

As part of the Remedial Action Plan, the following monitoring programs would be developed.

Baseline Monitoring

The database of information from all Site studies will be reviewed to ascertain whether an adequate statistical database is available to provide the basis for determining whether performance criteria are achieved. Based upon this review additional baseline sampling may be necessary.

Implementation Monitoring

Monitoring during implementation of the remedy will be conducted to ensure that remediation is being conducted in accordance with the Remedial Action Plan and that all project design specifications including performance of the contractor and environmental controls are met.

Verification Monitoring

Of particular importance to removal alternatives, verification monitoring determines whether performance criteria established for environmental media cleanup levels are met. This will be especially important for those areas outside the dredge perimeter which will be monitored to evaluate natural recovery.

Operations and Maintenance Monitoring

An operations and maintenance monitoring plan will be developed as part of the Long Term Monitoring Plan and will include several aspects of CDF performance including:

a. Contaminant transport from the CDF;
b. Verification of hydraulic control; and
c. Physical integrity of CDF.

Long-term Monitoring

Long-term monitoring is primarily focused on verifying the continuing achievement of PRGs. It is of particular importance if any PRG is to be met through natural recovery mechanisms. Contingency plans will be implemented in instances where expected results of remediation, PRGs, are not met.

8.3.2.6 Cost

The cost for this alternative is estimated at approximately $35,000,000. Various cost elements are summarized in Table 8-2.

Table 8-2 - Cost Summary – Alternative SED-2: CDF

Task	Estimated Cost*
Mob/Demob & Miscellaneous	$1,200,000
Construct CDF	14,400,000
Dredge	5,100,000
Compensatory Mitigation	1,500,000
Long Term Monitoring	700,000
Total Estimated Cost	**$37,000,000**

*Only Total Cost includes oversight and administration, engineering and contingency.

8.3.3 Alternative SED-3: Subaqueous Capping

8.3.3.1 Introduction

Alternative SED-3 would consist of sediment and debris removal, subaqueous capping, dewatering, consolidation, and off-site disposal with or without on-site treatment, combined with MNR. The shallow nature of nearshore portions of the Site requires that some dredging be completed prior to capping so that the cap remains subaqueous and doesn't interfere with navigation or recreational boating. In addition, because of the location, the cap would have to be armored to resist erosion from waves or ice damage. A four foot depth was selected as a conceptual basis for costing because the requirements of cap design, i.e., prevention of contaminant transport and armoring to prevent ice damage, would likely require a cap of four feet thickness. The actual cap depth will be evaluated during Remedial Design and the dredge depth adjusted accordingly.

Costs estimates have been prepared for four options under this alternative:

Alternative SED-3A: Mechanical Dredging and Capping, No Decontamination of Sediment
Alternative SED-3B: Mechanical Dredging and Capping, Thermal Treatment of Sediment
Alternative SED-3C: Hydraulic Dredging and Capping, No Decontamination of Sediment
Alternative SED-3D: Hydraulic Dredging and Capping, Thermal Treatment of Sediment

This alternative is illustrated in Figure 8-7 and consists of the following components:

1) Determine the area of sediment containing significant wood debris and free-phase material with concentrations of PAH greater than 9.5 ug PAH/g dwt at 0.415% OC;
2) Remove approximately the top four feet of sediment in these areas using one or more of the following means from barge-based or land-based platforms:
    a. hydraulic dredging;
    b. mechanical dredging; and/or

   c. excavation.
3) In areas where PAH levels do not exceed 9.5 ug PAH/g dwt at 0.415% OC at depths greater than approximately six feet, all sediment exceeding 9.5 ug PAH/g dwt at 0.415% OC will be removed. This is approximately the areas depicted in Figure 8-8.
4) Dewater dredged sediment on site using a settling pond and mechanical separation followed by on-site treatment of sediment and liquid or off-site disposal of untreated sediment;
   a. If sediment is treated using thermal desorption or incineration it would be sent for off-site disposal at a solid waste or other landfill after treatment;
   b. If sediment is not treated on site but only stabilized, it would be sent to a NR 500 permitted landfill for off-site disposal;
   c. Wastewater would be treated using flocculation, clarification, sand filtering, and carbon filtering and discharged to the Ashland WWTP. Alternatively it could be discharged directly to Lake Superior if it met DNR surface water criteria;
5) Construct subaqueous armored cap over dredged area (Figures 8-8 and 8-9); and
6) Monitor sediment areas outside of cap where concentrations of PAH greater than 5.6 µg PAH/g dwt at 0.415% OC have been observed.

Subaqueous capping would make use of a variety of materials, including some that would be reactive with site contaminants to contain contaminants in situ, e.g. organo-clays or activated carbon. A properly designed cap would significantly decrease contaminant mobility and isolate the contaminants from the overlying water column, thus preventing exposure to ecological receptors or humans by covering the sediment.

Equipment that may be used for implementation of this alternative includes:

- Dredging equipment – for removing sediment from the lakebed
  - Hydraulic
  - Mechanical
  - Excavation equipment (long stick excavators)
- Excavation equipment – for construction of dewatering basins
  - Traditional
- Transportation equipment – for dredging and moving sediment from the dredge to the dewatering basins
  - Barge
  - Piping
- Dewatering equipment – for removing water from sediment prior to treatment or disposal
  - Settling ponds
  - Mechanical dewatering equipment
- Treatment equipment
  - LTTD
  - HTTD
  - Incinerator
  - Water treatment system
    - Flocculation

        - Clarification
        - Sand filtration
        - Carbon filtration
        - Oil/water separator
    - Solidification
- Disposal equipment
    - Piping to lake or WWTP for treated water
    - Transport to disposal location
        - Rail
        - Truck
        - Barge
- Monitoring equipment – to evaluate effectiveness of remedy
    - Groundwater monitoring wells
    - Piezometers for water level measurements
    - Sediment sampling equipment
    - Surface water sampling equipment

8.3.3.2 Concept

The subaqueous capping alternative was selected for consideration because implementation of this alternative would meet the RAOs through capping of sediment that poses potential risk to human health and the environment. The cap would be designed to prevent access to impacted sediment with concentrations greater than 9.5 ug PAH/g dwt at 0.415% OC, as well as minimize migration of VOCs, SVOCs and NAPL from within the sediment to surface water and unimpacted areas.

As previously stated, up to four feet of wood debris and sediment would be removed from the cap area prior to constructing the cap in order that the finished project depths approximate existing bathymetry. Figure 8-8 provides a plan view of the cap location.
Sediment removal under this alternative would be conducted with excavators, mechanical dredges and/or hydraulic dredges. In some nearshore areas, caissons could be constructed to enable dewatering nearshore areas, which would allow use of shore-based excavators to remove sediment. The efficacy of this latter approach could be determined during a pilot scale project.

Engineering controls would need to be implemented to minimize volatilization of VOCs during dredging. This can best be evaluated during a pilot scale project. During dredging operations, turbidity curtains and floating hydrocarbon booms or sheet piling, if necessary, would be deployed to minimize dispersal of suspended sediments or floating free phase.

The subaqueous cap would be constructed over approximately seven and one-half acres of lake bed. Following construction, there would be no restrictions on usage of the capped area. Areas outside the cap area that are dredged would be covered with six inches of clean sediment to encourage recruitment of benthic organisms.

8.3.3.3 Rationale and Precedent

Subaqueous capping reduces risk associated with impacted sediment by eliminating the possibility of contact with sediment through removal and containment. In order to allow continued use of the area for water recreation, sufficient thickness of sediment would be removed to allow the cap to be placed without changing the elevation of the lake bottom in the area being capped.

Subaqueous caps have been constructed at numerous locations across the U.S. including at over 15 Superfund sites (USEPA 2005). Capping has also been used at sites where contaminants, including NAPL, similar to those found in Site sediments are found. These Superfund sites include McCormick and Baxter Site in Portland, Oregon where approximately 20 acres of creosote containing sediment was capped and Pine Street Canal in Vermont. Of particular relevance is the McCormick and Baxter Superfund Site where granular organoclay and organoclay blankets in the cap were used to manage NAPL migration as well as gas release.

Appendix G provides a summary of capping projects that have been implemented or were planned as of 2002.

USEPA addresses capping as a viable response action for CERCLA sites in its latest contaminated sediment guidance (EPA Sediment Guidance: USEPA 2005). The science and engineering of designing caps started over 25 years ago and since then much has been written about it. As discussed in the EPA Sediment Guidance,

> "The majority of this work has been performed by, or in cooperation with, the U.S. Army Corps of Engineers (USACE). Comprehensive technical guidance on in-situ capping of contaminated sediment can be found in the EPA's Assessment and Remediation of Contaminated Sediment (ARCS) Program Guidance for In-Situ Subaqueous Capping of Contaminated Sediments (U.S. EPA 1998d) and the Assessment and Remediation of Contaminated Sediments (ARCS) Program Remediation Guidance Document (U.S. EPA 1994d), available through EPA's Web site at http://www.epa.gov/glnpo/sediment/iscmain. Additional technical guidance is available from the USACE's Guidance for Subaqueous Dredged Material Capping (Palermo et al. 1998a)."

8.3.3.4 Site-specific Elements of a Subaqueous Cap Design

There are several site-specific factors that will be considered during Remedial Design. These include the physical characteristics of the Site as well as the results of the Treatability Studies that were conducted in support of this FS (See Section 4.0 and Appendices E, F, and G).

Site Characteristics

The site sediment characteristics were described in the Cap Flux Testing report (Appendix B2). The substrate in the Site area includes layers of contaminated wood, sand and silt. The wood layer that is generally located near the sediment surface would be a large percentage of the top four feet of dredged material in this area. The wood layer is thicker nearshore and thinner further offshore. Sand and silt layers would comprise the sediment types below and mixed with this wood layer.

Since NAPL was observed in the wood layer and in the Miller Creek sand and silt layers, the potential for NAPL mobility within the subaqueous cap will be considered in design using the results from the Multiphase Testing. In addition, collection and removal of NAPL during placement of dredge materials into the dewatering system will be addressed during Remedial Design.

The potential for transport of NAPL due to ebullition also will be evaluated during Remedial Design. Both the Cap Flux Test (Appendix B2) and the Multiphase Testing (Appendix B4) provided information on this transport mechanism.

In addition, since the several layers of sediment potentially have elevated levels of VOCs, including benzene, naphthalene and methylnaphthalene, control of emissions from these sediments also will be evaluated during Remedial Design.

Implications of Treatability Studies

As discussed in Section 4.0 several treatability studies have been conducted to support remedial alternatives screening for sediment. The following sections briefly discuss the implications of these studies to the design and construction of the subaqueous cap.

Ebullition and Related NAPL Transport

Based on the Cap Flux Test (Appendix B2) sediments at 20^{O} C and higher generated gas. Based upon this test the rate of gas generation and ebullition increased with higher temperatures and over longer testing periods. However, the capped columns did not show that the NAPL was transported through the caps even after six months of testing. Further, the results of the Multiphase Testing (Appendix B4) indicated that NAPL would not be mobilized by the cap during consolidation.

Consolidation of Sediments

Based upon the results of two of the treatability studies there is expected to be some consolidation of the cap after placement. Minimal consolidation was measured during Cap Flux testing, however, the DELCON modeling conducted as part of the Multiphase Testing (Appendix B4) indicated that most of the compressibility of the cap would occur where there is still a wood layer beneath the cap. Under a four-foot cap up to 0.29 ft of consolidation is estimated. The data from these tests will be used in the capping design.

Contaminant Transport

Upward groundwater flow at the site is not expected to be significant based upon hydraulic evaluations conducted during the RI (URS 2006) due to the presence of the Miller Clay barrier to the Copper Falls aquifer. However, some contaminated groundwater may be discharged from the Kreher Park area along the shore line. To account for this potential the Cap Flux testing (Appendix B2) was conducted with an upward gradient through the sediment and caps. Even with this head applied none of the caps detected significant transport of contaminants from the underlying sediments into the cap. These data will be used in designing the caps during Remedial Design.

Air Emissions

The air emissions testing (Appendix B3) concluded that under some conditions VOCs potentially would be transported to locations where the public would be exposed VOCs above relevant health criteria. Odor was also shown to be potentially a concern in these areas. Emissions under this alternative were predicted to be similar for dredging in this alternative as for Alternative SED-4, only of shorter duration. As a result, engineering controls and response action plans will have to be developed as part of Remedial Design.

8.3.3.5 Implementation of Remedy

Mobilization/Demobilization

This includes mobilization and demobilization of all the equipment and facilities needed to implement this alternative. This is estimated to be 5% of the remedial costs.

Sediment Removal

Under this alternative, sediment overlying areas with large quantities of wood debris and areas containing NAPL would be dredged to a depth of approximately four feet. In some areas dredging will go deeper if it is judged more cost efficacious to dredge the extra depth rather than cap. This will be determined as part of Remedial Design based upon verification sampling.

Sediment removal under this alternative would be conducted with excavators, mechanical dredges and hydraulic dredges. Excavators and/or mechanical dredges would be used to remove debris from the targeted areas. In some places near shore caissons could be constructed to enable dewatering, which would allow use of shore-based excavators to remove sediment. The efficacy of this latter approach will be determined during a pilot scale project.

After removal of debris, hydraulic dredges would be employed to dredge sediments above the PRG. The dredge slurry will be pumped to an onshore dewatering and treatment facility. Engineering controls likely will need to be implemented to minimize volatilization of VOCs during dredging. Engineering controls for dredging are discussed at greater length in Section 8.3.4. The potential for volatilization can best be evaluated during a pilot scale project.

Performance objectives for dredge residuals and resuspension and control of volatilization and odor would be as discussed for Alternative SED-2 (Section 8.3.2.).

Sediment Dewatering

Dewatering includes screening operations to remove large wood debris and operation of the plate and frame filter presses for dewatering (in the case of hydraulic dredging) prior to final sediment treatment. Also included in this alternative is about a four acre pond system and stockpile area built at Kreher Park area with a lined earthen dike. A layout drawing of the site sediment processing area is shown in Figure 8-10. Costs are included in the sediment treatment category discussed later. Volumes of dredged sediment slurries are estimated to be 13,000,000 gallons for mechanical dredging and 70,000,000 gallons for hydraulic dredging. No VOC controls have been included in costs at this time. However, based upon the results of the treatability studies they may be needed due to the naphthalene and benzene emissions.

Wastewater Treatment

Water treatment includes sand filtration, oil/water separators, carbon filtration and related testing for discharge. Discharge will be to the Lake Superior or City of Ashland WWTP. Quantities range from about 7,790,000 gallons under mechanical dredging options to 70,000,000 gallons for hydraulic dredging. Costs for this are included in the sediment treatment category discussed in the next section. Most of the systems are closed and should have minimal impact on air emissions or have emission controls.

Sediment Treatment

Sediment treatment includes either stabilization for direct disposal at a ch. NR 500 permitted landfill, or alternatively thermal treatment to destroy the organics before landfilling (Figure 8-7). Both processes have the potential to create some emissions. However, this potential is much lower during dewatering operations unless there is an upset in the operations. The sediment treatment volumes are the same for all mechanical and hydraulic dredging options since they would all achieve the same dewatered feed volume of approximately 38,000 cy. The volume and weight after treatment is higher for stabilization since the process would add 10% more weight. Weight is estimated at 58,000 tons. On the other hand, thermal treatment would reduce the water weight and not require stabilization. This process would generate approximately 37,000 tons for disposal, including 5% moisture added to control dust and facilitate handling. HTTD was assumed to be the most cost effective thermal method and is the basis for the cost estimates. However additional design testing would be needed to evaluate this choice.

Sediment handling costs that include sediment dewatering, water treatment and sediment treatment are shown in Table 8-3. The major differences in cost are due to water treatment costs for hydraulic dredging and difference in stabilization versus thermal treatment costs.

Sediment Disposal

The disposal process will include the loading of sediment following drying and treatment/stabilization at the Site, and transportation to a commercial/industrial landfill or NR 500 permitted landfill. Several scenarios were evaluated for this option, assuming a sediment quantity of 78,000 cy based upon the sediment PRG. These scenarios were discussed in the CAATM (Appendix A2). For purposes of cost estimation it is assumed one cubic yard of sediment will weigh 1.5 tons.

Other Disposal Alternatives

As previously discussed, NSPW also may initiate siting of a ch. NR 500, WAC landfill in the Ashland area for solid materials removed from the Lakefront Site. This disposal option is dependent on the material volume. An analysis of siting a landfill in accordance with ch. NR 500 WAC in the Ashland area is discussed in Appendix I.

Wood Waste

There is the potential for generating a substantial quantity of wood waste if sediments are removed. The wood waste ranges in size from sawdust and chips to timber. Potentially, the larger debris could be burned as fuel at the NSP Bayfield Power Plant located in Ashland. Some additional maintenance at the plant would be required to accommodate the wood debris but this is considered a viable option at this time and will evaluated further during Remedial Design.

Ancillary Solid Wastes

Waste such as PPE, construction debris and other types of solid wastes generated during the conduct of remedial activities can be disposed of at a local municipal landfill. This management method will be used in all remedial alternatives. The quantity generated will depend on the remedial alternative. PPE will be evaluated and handled in accordance with USEPA guidance document to handle investigation derived waste (USEPA 2007).

Construction of Subaqueous Cap

A subaqueous cap will be designed for placement over the area that has been dredged to four feet but still has sediments beneath this depth exceeding the sediment PRG. Dredging to four feet will provide sufficient depth for placement of an armored cap while not decreasing the lake bottom depth. Cap material considered in this application would be natural sand, organoclays and/or carbon or other amendments to adsorb contaminants, as well as armoring to resist erosion. A cross section of a conceptual cap is depicted in Figure 8-9.

As presently conceived, the cap will consist of first installing organoclay blankets over the area to be capped. As an alternative, a geotexile with activated carbon or bentonite sandwiched between a needle point punched mat may be installed. This will require first placing a 6-9 inch sand layer for protection from debris and levelling the surface. After installing the organoclay blanket, a two and one-half foot sand cover then would be placed over the area to be capped using a spreader barge, clam shell dredge or excavator on a barge. The sand cover would be added in 6-12" lifts to allow for consolidation of the underlying sediments to account for differential settlement. The sand cap would provide containment and allow the sediments to gain strength and stability with the consolidation from the cap load. In areas where the water is less than six feet deep armoring using gravel, cobble or stone rip rap would be added for wave and ice protection depending upon the water depth and anticipated erosion forces. A post capping bathymetric survey would be conducted to assure proper coverage and as a baseline for future measurements.

Monitoring

Monitoring options for this alternative would be the same as those listed in Section 8.3.2, with the exception that the monitoring plan would be geared toward monitoring the effectiveness of a subaqueous cap rather than a CDF.

8.3.3.6 Cost

The total cost for this alternative ranges from approximately $38, 321,000 to $59,223,000 depending upon whether the sediment is mechanically or hydraulically dredged and whether thermal treatment is needed. Cost elements are summarized in Table 8-3.

Table 8-3. - Cost Summary – Alternative SED-3: Dredge/Cap.

Task	Estimated Cost*			
	SED-3A	SED-3B	SED-3C	SED-3D
	Mechanical Dredge - No Treatment	Mechanical Dredge - Thermal Treatment	Hydraulic Dredge - No Treatment	Hydraulic Dredge - Thermal Treatment
Mob/Demob & Miscellaneous	$900,000	$1,100,900	$1,100,000	$1,300,000
Dredge & Sediment Handling[1]	11,700,000	10,200,000	11,100,000	10,200,000
Cap	2,500,000	2,500,000	2,500,000	2,500,000
Water Treatment	1,700,000	1,700,000	6,200,000	6,200,000
Transport and Disposal	2,700,000	1,800,000	2,700,000	1,800,000
Long Term Monitoring	700,000	700,000	700,000	700,000
Total Estimated Cost	**$30,100,000**	**$34,500,000**	**$36,400,000**	**$41,700,000**

* Only Total Cost includes oversight and administration, engineering and contingency.
1: Sediment handling includes screening, dewatering, treatment and/or stabilizing if necessary.

8.3.4 Alternative SED- 4: Removal

8.3.4.1 Introduction

Alternative SED-4 would consist of removal, dewatering, consolidation, and off-site disposal with or without on-site treatment, combined with MNR. Under this alternative, the greatest amount of sediment would be removed, treated and disposed.

Costs estimates have been prepared for four options under this alternative:

Alternative SED-4A: Mechanical Dredging, No Decontamination of Sediment
Alternative SED-4B: Mechanical Dredging, Thermal Treatment of Sediment
Alternative SED-4C: Hydraulic Dredging, No Decontamination of Sediment
Alternative SED-4D: Hydraulic Dredging, Thermal Treatment of Sediment

This alternative, illustrated in Figure 8-11, consists of the following components:

1) Determine sediment with concentrations of PAH greater than 9.5 ug PAH/g dwt at 0.415% OC;
2) Remove these sediments using one or more of the following means from barge-based or land-based platforms:
    a. hydraulic dredging;
    b. mechanical dredging; and/or
    c. excavation.
3) Dewater dredged sediment on site using a settling pond and mechanical separation followed by on-site treatment of sediment and liquid and/or off-site disposal of untreated sediment;
    a. If sediment is treated using thermal desorption or incineration it would be sent for off-site disposal at a solid waste or other landfill after treatment;
    b. If sediment is not treated on site but only stabilized, it would be sent to a NR 500 permitted landfill for off-site disposal;
    c. Wastewater will be treated using flocculation, clarification, sand filtering, and carbon filtering and discharged to the Ashland WWTP. Alternatively it could be discharged directly to Lake Superior if it met DNR surface water criteria;
4) Monitor sediment areas outside of cap where concentrations of PAH greater than 5.6 µg PAH/g dwt at 0.415% OC have been observed.

Equipment that may be used for implementation of this alternative includes:

- Dredging equipment – for removing sediment from the lakebed
    - Hydraulic
    - Mechanical
    - Excavation equipment (long stick excavators)
- Excavation equipment – for construction of dewatering basins
    - Traditional

- Transportation equipment – for dredging and moving sediment from the dredge to the dewatering basins
  - Barge
  - Piping
- Dewatering equipment – for removing water from sediment prior to treatment or disposal
  - Settling ponds
  - Mechanical dewatering equipment
- Treatment equipment
  - LTTD
  - HTTD
  - Incinerator
  - Water treatment system
    - Flocculation
    - Clarification
    - Sand filtration
    - Carbon filtration
    - Oil/water separator
  - Solidification
- Disposal equipment
  - Piping to lake or WWTP for treated water
  - Transport to disposal location
    - Rail
    - Truck
    - Barge
- Monitoring equipment – to evaluate effectiveness of remedy
  - Groundwater monitoring wells
  - Piezometers for water level measurements
  - Sediment sampling equipment
  - Surface water sampling equipment

8.3.4.2 Concept and Precedent

Removal by dredging is generally the presumptive remedy for contaminated sediment if cost and/or risk factors don't result in other alternatives being favored. Removal of contaminated sediment with dredges or excavators has been successfully implemented at a number of contaminated sediment sites.

Removal is technically feasible for the Site, although several issues would have to be addressed in the design of a dredging alternative, including control of the release of free-phase product and dispersal and volatilization of VOCs during dredging activities, as well as management of dredging residuals and handling of a substantial amount of wood debris. Some aspects of the Site are more disposed to the use of mechanical dredges or excavators (e.g., debris removal), while other aspects favor hydraulic dredges, (e.g., capture of free phase and minimization of volatilization).

Under this alternative, sediments greater than 9.5 ug PAH/g dwt at 0.415% OC would be removed regardless of depth. In some areas, sediments as deep as ten feet would be removed. Sediment removal under this alternative would be conducted with excavators, mechanical dredges and hydraulic dredges. In some nearshore areas, caissons could be constructed to enable dewatering nearshore areas, which would allow use of shore-based excavators to remove sediment. The efficacy of this latter approach could be determined during a pilot scale project.

Engineering controls would need to be implemented to minimize volatilization of VOCs during dredging. This can best be evaluated during a pilot scale project. During dredging operations, turbidity curtains and floating hydrocarbon booms or sheet piling, if necessary, would be deployed to minimize dispersal of suspended sediments or floating free phase. Site restoration would include placing six inches of clean sediment on areas that have been dredged.

8.3.4.3 Implementation of Remedy

Mobilization/Demobilization

This includes mobilization and demobilization of all the equipment and facilities needed to implement this alternative. This is estimated to be 5% of the remedial costs.

Sediment Removal

Under this alternative, sediments greater than 9.5 ug PAH/g dwt at 0.415% OC would be removed regardless of depth. In some areas, sediments as deep as ten feet would be removed. The removal alternative would likely feature all three removal technologies, use of mechanical dredging and/or excavation to remove debris and hydraulic dredging once a sufficient amount of debris is removed[26]. Debris close to shore might also be removed by long-armed excavators operating from shore or even from temporary piers made from modularized barges. To minimize volatilization of VOCs and SVOCs and dispersion of free phase, the dredging operation would likely employ modular pontoon barges or scows that are configured in such a manner that turbidity "skirts" can be placed around them. Debris removal and dredging will take place in the "hole" made by the arrangement of pontoons or scows. Various equipment including boom cranes, ladder cranes, hydraulic heads or excavators would operate off of these platforms depending upon their effectiveness. In areas where the presence of debris doesn't interfere with hydraulic dredging, hydraulic pumps on excavators might be used. The scows or pontoon barges would be moved around using either a tug or wires connected to the shore. Anchor spuds could not be used in the free phase areas as they may disturb the sediments and release free phase and buried contaminants.

Once dredged or excavated, debris and the sediment/debris mixture can be passed through "grizzlies" to separate out large wood into hoppers or scows with mud locks. Water can be added to the sediment and moved hydraulically to dewatering and treatment areas.

[26] Various hydraulic equipment such as cutterhead dredges can deal with a certain amount of wood debris provided it is relatively soft. A cutterhead dredge can crush the wood debris into smaller pieces and hydraulically move it with the sediment to separation and treatment facilities.

Under this alternative, engineering controls would need to be implemented to minimize volatilization of VOCs during dredging. Approaches to control volatilization are discussed further below. The need for and design of engineering controls for volatilization would need to be evaluated during a pilot scale project. During dredging operations, turbidity curtains and floating hydrocarbon booms would be deployed to minimize dispersal of suspended sediments or floating free phase. If necessary, sheet piling would be deployed to minimize dispersal of suspended sediments or floating free phase.

Performance objectives for dredge residuals and resuspension and control of volatilization and odor would be as discussed for Alternative SED-2 (Section 8.3.2). The potential for unacceptable volatilization is substantially greater for this alternative since more areas where levels of NAPL and volatile VOCs are greater would be dredged. Based upon the results of the Air Emissions Treatability Study (Appendix B3) volatiles are expected to disperse beyond the immediate vicinity of dredging operations and onshore treatment operations, depending upon ambient weather conditions. With the proximity of a relatively large population in Ashland, this presents the real possibility of unacceptable exposure unless volatiles can be controlled. Controls for minimization of volatile releases are available for onshore operations; however, volatilization control for operations on the water would have to be investigated further during a pilot scale project, since tenting over working dredges on the water is difficult and would add complexity to maintaining efficient dredge production rates. Beyond controls that can be employed by the dredge operator to minimize exposure of sediment to air there is little precedent for implementing engineering controls for volatilization at the dredge platform. Dredging areas with a high potential for release of volatiles during cooler periods of the year or when winds are predominantly offshore also may help minimize transport of volatiles to residential areas. However, it is likely that dredging will be shut down in the colder months of the year and wind directions in the Ashland area are variable and sometimes unpredictable.

Table 8-4 summarizes controls that are available for the activities associated with a removal remedy. At Stryker Bay Site on the St. Louis River similar impacts from volatile emissions were anticipated so several additional engineering controls were evaluated. The controls evaluated and the results of the evaluation are summarized below in Table 8-5.

After dredging is completed, six inches of clean sediment would be placed on areas that are dredged. This would help in covering any dredging residuals as well as providing a better habitat for recruitment of benthic macroinvertebrates and for spawning of fish. In addition, because this alternative would result in substantial changes to the bathymetry of the nearshore waters at the Site, approximately 30,000 of clean fill will have to be placed in the nearshore areas to partially restore pre-dredge bathymetry.

Table 8-4 Potential Engineering Controls

Remedial Activity	Engineering Control Options
Debris removal using clamshell dredge	1) Dredge within area surrounded by turbidity screens or modular barges to prevent dispersal of resuspended sediment and subsequent volatilization. 2) Dredge with a bucket designed to hold large debris, e.g. logs, but to let sediment escape underwater. 3) Keep debris underwater until in immediate area of trash handling system. However, a majority of the emissions are caused by the contaminant dissolved phase and at the air/ water interface.
Sediment dredging	1) Operator controls: Don't overfill bucket, etc. 2) Dip buckets before bringing out of water in order to dislodge mud. 3) Use drip pans and wash tanks to catch any loose sediment and to wash sediment off of dredge bucket. 4) Utilize hydraulic dredging after debris removal. However, an increased dissolved phase will exist in the dewatering ponds. 5) To the extent practicable, dredge most highly impacted areas during cooler weather or during periods when winds are predominantly offshore.
Conveyance of dredge material to sediment treatment facilities	1) Avoid storing sediment in open barges, even temporarily. 2) Use closed circuit conveyance system. 3) Avoid storage of material in open piles while awaiting sediment or water treatment.
Sediment and water treatment	1) Store material in enclosed facilities where practicable. 2) Use negative air pressure with storage facilities where necessary. Air should be drawn from work areas and the air filtered. 3) Use covered areas or bladders (e.g. geotubes) for sediment settling. 4) Conduct water treatment, e.g. presses or hydrocyclones, in enclosed facilities where necessary. 5) Use floating covers on dewatering ponds or on CDF water surface. 6) Use a tremy for underwater discharge of sediment slurries to minimize mixing during placement in a CDF or deep impoundment.
Sediment transport	All trucks, rail cars or barges used to transport sediment for disposal should be properly lined and sealed.

Table 8-5. Alternatives for Controlling Volatilization Evaluated at Stryker Bay*

Engineering Control for Volatile Emissions from Dredging	Effectiveness
Dredging under poly cover	1) Difficult to conduct dredging activities within a covered area and reduces production. 2) Difficult to maintain a cover while on the water under a range of weather conditions.
Covering water surface with balls	Have been used in pond conditions, but they can also create films where NAPL is present and increase the surface area for volatilization. Balls also can escape from containment curtains in dredging areas due to wind and waves.
Foam blankets	Dissipate rapidly in windy and wavy conditions and are hard to maintain.
Water spray curtains	Used as a boundary for sensitive areas near shoreline, but causes increased humidity and subject to disruption from winds.

*Personal communication, Hubert Huls, URS.

Sediment Dewatering

Dewatering is similar to Alternative SED-3 and includes screening to remove large wood debris and operation of plate and frame filter presses for dewatering (if hydraulic dredging is used) prior to final sediment treatment. Also included is about a four acre pond system and stockpile area built on the Kreher Park area built with a lined earthen dike (Figure 8-10). Costs for that are included in the sediment treatment category discussed later. Volumes of dredged sediment slurries are estimated at 21,900,000 gallons for mechanical dredging and 131,700,000 gallons for hydraulic dredging. No VOC controls have been included in costs at this time. However, they may be needed due to naphthalene and benzene emissions. Since the dredging and dewatering are greater volumes than in Alternative SED-3, the emissions will also be last longer.

Wastewater Treatment

Water treatment is also similar to Alternative SED-3 and includes sand filtration, oil/water separators, carbon filtration and related testing for O&M and discharge. Discharge will be to the City of Ashland WWTP or to Lake Superior if it meets WDNR water quality criteria. Estimated treatment quantities range 13,400,000 gallons for mechanical dredging to 121,000,000 gallons for hydraulic dredging. Costs are included in the sediment treatment category discussed later. Most of the systems are closed and should have minimal impact on air emissions.

Sediment Treatment

Sediment treatment is the same as for Alternative SED-3, however the volumes are larger. Sediment treatment includes either stabilization for disposal in a NR 500 permitted landfill or alternatively, thermal treatment before land filling in a solid waste landfill. Both processes have the potential to create some emissions in handling the dewatered sediment feed to the stabilization or thermal treatment systems. However, there is likely much lower emissions associated with sediment treatment than with the dewatering operations unless there is an upset in the operations. The sediment treatment volumes are the same for all mechanical and hydraulic dredging options since they would all achieve the same dewatered feed volume of approximately 64,000 cy. The volume and weight after treatment is higher for stabilization (99,000 tons) since it would add 10% more weight. Thermal treatment would reduce the water weight and with no added material would result in approximately 58,500 tons for disposal. HTTD is again assumed to be the most cost effective thermal method and is the basis for cost estimates for thermal treatment at this time. However additional design testing would be needed to evaluate this choice.

Sediment handling costs include sediment dewatering, water treatment and sediment treatment as shown in Table 8-6. Major cost differences are due to water treatment costs for hydraulic dredging and difference in stabilization versus thermal treatment costs.

Sediment Disposal

The disposal options under this alternative are the same as for Alternative SED-3 (Section 8.3.3). There is just more sediment to dispose.

Other Disposal Alternatives

As previously discussed, NSPW also may initiate siting of a NR 500 permitted landfill in the Ashland area for solid materials removed from the Lakefront Site. This disposal option is dependent on the material volume. An analysis of siting an upland NR 500 permitted landfill in Ashland is presented in Appendix I.

Wood Waste

Under this alternative there is the potential for generating a substantial quantity of wood waste. The wood waste ranges in size from sawdust and chips to timber. Potentially, the larger debris could be burned as fuel at the NSP Bayfield Power Plant located in Ashland. Some additional maintenance at the plant would be required to accommodate the wood debris but this is considered a viable option at this time and will evaluated further during remedial design.

Ancillary Solid Wastes

Waste such as personal protective equipment (PPE), construction debris and other types of solid wastes generated during the conduct of remedial activities can be disposed of at a local municipal landfill. The quantity generated will depend on the remedial alternative. Personal protective equipment (PPE) will be evaluated and handled in accordance with USEPA guidance document to handle investigation derived waste (USEPA 2007).

Monitoring

Monitoring options for this alternative would be the same as those listed in Section 8.3.2 with the exception of those elements relating to CDF or cap performance.

8.3.4.4 Cost

The total cost for this alternative ranges from approximately $42,152,000 to $82,496,000 depending upon whether the sediment is mechanically or hydraulically dredged and whether thermal treatment is needed. Cost elements are summarized in 8-6.

Table 8-6 - Cost Summary – Alternative 4: Dredge All

Task	Estimated Cost*			
	SED-4A	SED-4B	SED-4C	SED-4D
	Mechanical Dredge - No Treatment	Mechanical Dredge - Thermal Treatment	Hydraulic Dredge - No Treatment	Hydraulic Dredge - Thermal Treatment
Mob/Demob & Miscellaneous	$1,300,000	$1,500,000	$1,600,000	$1,900,000
Dredge & Sediment Handling	18,600,000	16,000,000	17,600,000	16,000,000
Water Treatment	2,300,000	2,300,000	10,100,000	10,100,000
Transport and Disposal	4,600,000	3,000,000	4,400,000	3,000,000
Long Term Monitoring	700,000	700,000	700,000	700,000
Total Estimated Cost	**$41,200,000**	**$48,900,000**	**$51,600,000**	**$61,100,000**

* Only Total Cost includes oversight and administration, engineering and contingency.
1: Sediment handling includes screening, dewatering, treatment and/or stabilizing if necessary

8.3.5 Alternative SED-5 – Dry Excavation

8.3.5.1 Introduction

Alternative SED-5 would consist of diverting water away from the targeted sediment area by construction of a barrier around the area to be remediated, removing standing water from the isolated area, continually pumping seepage from lake and groundwater to maintain conditions as dry as possible; and removing sediment using conventional earth moving technology. The remaining elements of this alternative are the same as in Alternative SED-4 and include, dewatering and consolidation of sediment and off-site disposal with or without on-site treatment. Under this alternative, the same amount of sediment as in Alternative SED-4 would be removed, treated and disposed.

This alternative, illustrated in Figures 8-12 through 8-18, consists of the following components:

1) Determine sediment with concentrations of PAH greater than 9.5 ug PAH/g dwt at 0.415% OC and areas where significant wood debris has been deposited;
2) A wave attenuation flotation device and sheet piling (alternatively a stone breakwater) would be constructed in the bay along the proposed alignment at 3,000N (approximate location);
3) Steel sheet pile containment wall would be constructed along 2,900N (approximate alignment.
4) Lake water within the containment will be removed with 2- 500 gpm, stand-alone pumps. Lake water pumped from within the containment will be managed/treated by an adsorbent liquid phase activated carbon system sized to adequately remove contaminants of concern. The untreated lake water will be tested to provide contaminant mass loading data and the carbon will be changed out and regenerated based upon the contaminant load. The treated effluent will be discharged directly to Lake Superior following laboratory testing that shows compliance with WDNR water quality criteria.
5) Variable rate discharge pumps will be used to assist with dewatering sediments. Wastewater obtained from sediment dewatering will be managed/treated with filtration of the solids followed by contaminant adsorption with liquid phase activated carbon filters. The wastewater will flow through bag or sand filters and will then flow into a liquid phase activated carbon system sized to remove contaminants of concern from the water. The wastewater will be tested to estimate the contaminant mass loading on the carbon, and the carbon will be changed out and regenerated on an as needed basis. In addition, the effluent will be tested to show compliance with WDNR water quality criteria, and discharged to the lake. Alternatively, if surface water criteria are not initially met, the water will be contained and re-treated, and the system will be adjusted to fully treat the water.
6) Wood debris and sediment will be prepared for loading and disposal by one of the following methods: Stabilizing wet, fine grained (silt and clay) sediments with reagents such as Type C flyash and/or Portland cement and excavation of wood debris and granular (sand and gravel) sediments on an asphalt pad to allow drainage of fluids by gravity flow.
7) Sediment excavation/stabilization/dewatered will be performed with heavy equipment such as a crane with drag-line and/or tracked excavator and/or wheeled conveyor and displacement with a bull dozer. It is anticipated that all of the sediment volume will be disposed off-site or thermally treated.
8) Monitor sediment areas outside of cap where concentrations of PAH greater than 5.6 µg PAH/g dwt at 0.415% OC have been observed.
9) Groundwater removed from the trench system that parallels the sheetpile wall on the land side will be treated with filtration, oil/water separation followed by treatment with liquid phase activated carbon. As with the other water that will enter the activated carbon system, water will be treated to comply with WDNR water quality criteria.

Equipment that may be used for implementation of this alternative includes:

- Construction of wave attenuation floatation device or breakwater and lakeside containment wall
    - Barge equipped with crane, pile driving hammer and steel sheet piles with interlock seal
    - Barge equipped with crane and carriage lift for placement of stone and barges loaded with blasted rock/cut limestone, or barges equipped with crane for placement of wave attenuation device and dead-man
    - Hydrocarbon collection booms
- Construction of landside containment wall
    - Crane, pile driving hammer and sheet piles with interlock seal
    - Hydrocarbon collection booms
- Dewatering equipment – for removing water from bay, groundwater collection trench and sediment
    - Trailer mounted 500 gpm pumps
    - Variable rate (10-100 gpm) sump pumps
    - Sump pump for collection of drained sediment fluids from asphalt drainage pad
    - Mechanical dewatering equipment
- Water treatment equipment
    - Piping to lake or WWTP for treatment of water and collected fluids
    - Water treatment system
        - Oil/water separator
        - Bag filtration
        - Activated carbon adsorption
- Sediment excavation equipment
    - Bulldozers
    - Excavators
    - Crane equipped with drag–line to move sediment into position for handling and stabilization
    - Wheel mounted conveyors
- Sediment stabilization/drainage equipment
    - Backhoes
    - Compressors
    - Tanker trucks containing reagent
    - Asphalt drainage pad and sump
- Disposal equipment
    - Transport to disposal location
        - Truck
- Monitoring equipment – to evaluate effectiveness of remedy
    - Groundwater monitoring wells
    - Piezometers for water level measurements
    - Sediment sampling equipment
    - Surface water sampling equipment

8.3.5.2 Concept and Precedent

The concept behind dry excavation is simple: remove the water that covers the sediment and use traditional excavation equipment to remove it. Advantages to this removal technology include being able to directly "observe" what is being removed, thus making sure all targeted sediment is removed and residuals are minimized. Critical issues to overcome include maintenance of a dewatered condition, especially along the coast of a Great Lake and, and the need to use Low Ground Pressure (LGP) excavation equipment because of the low bearing capacity of the dewatered sediment. The dry excavation method will also increase the potential for volatilization when sediments are exposed to the air. Alternatives for reducing the dynamic forces from lake waves include a wave dampening system and sheet pile containment wall. Alternatives include a stone breakwater or a parallel sheet pile wall system or coffer dams. Worker safety is of paramount concern in selecting the appropriate system.

Dry excavation has been used for removal of contaminated sediment from a variety of sites. This remedial technology is predominantly used for small streams or ponds that are amenable to dewatering by diverting the water around the target area or draining the water body. However, projects as large as the removal of over 500,000 cy of contaminated sediment have been conducted using dry excavation. Examples of sites in Wisconsin that have used dry excavation to remove contaminated sediment include Newton Creek/Hog Island Inlet, where approximately 46,288 cy yards were removed by dry excavation and Hayton Area Remediation Project, near Chilton, Wisconsin where approximately 16,300 cubic yards have been removed since 2001. Superfund sites where dry excavation has been used to remove some or all of the impacted sediment include Velsicol Chemical/Pine River in Michigan and Marathon Battery in New York.

8.3.5.3 Implementation of Remedy

Mobilization/Demobilization

This includes mobilization and demobilization of all the equipment and facilities needed to implement this alternative. This is estimated to be 5% of the remedial costs.

Construction of Temporary Wave Attenuation Device or Stone Breakwater

Wave dampening will be required to minimize dynamic forces on the containment wall. Two forms of wave dampening can be utilized, a temporary floating wave attenuation device or a permanent structure. Both forms of dampening are discussed below with the final selection to be determined at the Remedial Design stage.

Temporary Wave Attenuation Device

The partially assembled wave attenuator (Figure 8-17) will be shipped to the site on flat bed trailers. The device will be unloaded and placed onto a work barge for assembly along the proposed alignment. Installation along the alignment will occur by placing concrete dead-men along the alignment. The exposed rebar extending from the dead-men would be connected to metal shackles that are connected to a metal cable which connects to the metal rods on the wave attenuator. Adjustment of the cables length would be performed to maximize wave attenuation (Figure 8-18).

During winter the wave attenuator could remain in-place or be pulled below the surface of the water to a depth that would be below the bottom of the ice that customarily forms in the bay. After ice out in the Spring the attenuator could be retuned to its initial position by adjusting the cable attached to the dead-men. At the completion of the project the attenuator could be anchored to the bottom or cleaned and sold.

Stone Breakwater

Alternatively a stone breakwater could be constructed along the proposed alignment show on Figure 8-14. All of the breakwater construction activities will be performed from barges. The stone will be placed by cranes positioned on barges. Additional barges loaded with stone will be mobilized to the breakwater construction area. The bottom of the breakwater will consist of 6 to 12-in-diameter crushed rock base on which large 1 to 2 ton shot rock will be placed. The rock on the perimeter faces of the breakwater will be large stone, several feet in all dimensions and weigh several tons. The side slopes of the breakwater will be 3H:1V, with the breakwaters crest extending above the top of the water a minimum of 5 feet.

Containment Wall Installation

Landside containment wall construction will be performed by driving steel sheet piling that utilizes an interlock sealant to minimize seepage. The lake and landside sheet piling will be driven into the underlying Miller Creek formation approximately 20 feet and 5 feet, respectively. Prior to driving the sheet piling, an exploratory trench will be excavated along the land wall alignment to a depth of approximately 10 feet below ground surface to remove obstacles or debris that would prevent the sheeting from being installed.

The lakeside containment wall will be constructed from a barge by driving steel sheeting or Pipe/AZ sheeting combined wall system. Preliminary structural analysis of the Pipe/AZ wall system without the use of a stone breakwater indicates similar deflections to other systems with the stone breakwater in-place. This pipe pile/sheet pile wall system also minimizes the number of interlocks, which help in minimizing the volume of seepage through the wall as compared to other containment systems that were evaluated. The final design of the lakeside containment wall will be determined at the Remedial Design stage after geotechnical data is collected along the alignment.

Following completion of the containment wall system, the water within the containment will be removed using trailer mounted 500 gpm pumps. The discharged water from initial pumping within the containment wall will be transported to the WWTP and processed with minimal treatment. Variable rate discharge pumps will be deployed to reduce the water content of the sediments within the containment. This water will also be piped to the WWTP and processed using additional treatment.

Excavation/stabilization/disposal of sediments

The excavation of the wood debris will be performed with tracked mounted excavators and a crane equipped with a dragline and bucket. The excavated wood debris and some of the sediments that underlie the debris will be placed on the asphalt drying pad to allowing additional drainage of trapped fluids. The drained wood debris will be loaded into trucks for transport to the disposal facility or to the NSP Bayfield Power Plant for burning. Fluids collected at the drainage pad will be transferred to the WWTP for additional treatment before being discharged.

The silty/clayey sediments underlying the wood deposits will be stabilized with reagents prior to being loaded onto trucks for disposal. The reagent(s) will be of a type that will help to absorb the majority of the remaining fluids within the silty/clayey sediments. Concrete Jersey barriers will be used to separate the stabilization activity from other activities. Stabilization of the sediments will be performed by using a compressor to transfer the reagent provided in tanker trucks to the stabilization area. Mixing of the reagent with the sediments will be performed using an excavator bucket and/or bulldozers. The stabilized sediments will be loaded by excavator into trucks for transport to the disposal facility.

The underlying sandy granular sediments will be removed and placed on an asphalt drainage pad to allow additional drainage of fluids. The sandy material will be moved to the drainage pad using wheel mounted conveyors and/or tracked excavators and bull dozers. Drained sandy sediments will be loaded onto trucks for transport to a disposal facility. Fluids collected at the drainage pad will be transferred to the WWTP for additional treatment before being discharged.

The potential for unacceptable volatilization is substantially greater for this alternative since areas would be exposed to the air. Although a dry excavation scenario was not explicitly modeled in the Air Emissions Treatability Study (Appendix B3), volatiles are expected to disperse beyond the immediate vicinity of excavation and onshore treatment operations, depending upon ambient weather conditions. With the proximity of a relatively large population in Ashland, this presents the possibility of unacceptable exposure unless volatiles can be controlled.

As with other sediment alternatives, controls for minimization of volatile releases are available for onshore operations; however, volatilization control for nearshore dry excavation would have to be investigated further during a pilot scale project, since tenting over working excavators is difficult and would add complexity to maintaining efficient excavation/stabilization/disposal rates. Volatilization controls for dry excavation would be similar to those discussed in the previous section for dredging (Section 8.3.4) with the exception of those controls that take place under water. On the other hand, surrounding excavation areas with “tenting” may be more practical than surrounding dredging areas with “tenting”. Since the project duration is anticipated to be twice that of the other sediment alternatives the potential for volatilization is greater. In addition, it would preclude use of the Kreher Park for approximately two years longer than the other sediment alternatives.

After dredging is completed, six inches of clean sediment would be placed on areas that are dredged. This would help in covering any dredging residuals as well as providing a better habitat for recruitment of benthic macroinvertebrates and for spawning of fish. In addition, because this alternative would result in substantial changes to the bathymetry of the nearshore waters at the Site, approximately 30,000 cy of clean fill will have to be placed in the nearshore areas to partially restore pre-dredge bathymetry.

Sediment Dewatering

Dewatering of the sediment will be performed using variable rate discharge pumps that are placed in sumps pits located within the containment area and adjacent to the outermost containment wall. Additional drainage of wood debris and sandy granular sediments will be provided by placing these materials on the asphalt drainage pad built at the Kreher Park area. Sediment dewatering and seepage through the containment wall are estimated at 7,500 gal/day. No emission controls have been included in costs at this time. However, they may be needed due to VOC emissions. The emissions will last longer due to the large exposed area.

Wastewater Treatment

Water treatment is similar to Alternative SED-3 and SED-4 and includes bag/sand filtration, oil/water separation, adsorption with activated carbon filter and related testing for O&M and discharge. Most of the systems are closed and should have minimal impact on air emissions. Discharge will be to the City of Ashland WWTP or to Lake Superior if it meets WDNR water quality criteria. Estimated total treatment quantity for the dredge in the dry option is 180,000,000 gallons. The total treatment volume is based on a project duration of 3.8 years.

Sediment Treatment

Sediment treatment includes stabilization and/or gravity drainage of excess fluids followed by disposal in a solid waste landfill.

Sediment handling costs include sediment dewatering, water treatment and sediment treatment and are summarized in Table 8-7.

Sediment Disposal

The disposal options under this alternative are the same as for Alternative SED-3 (Section 8.3.3). There is just more sediment to dispose.

Other Disposal Alternatives

As previously discussed, NSPW also may initiate siting of landfill per ch. NR 500 requirements in the Ashland area for solid materials removed from the Lakefront Site. This disposal option is dependent on the material volume. An analysis of siting an landfill per ch. NR 500 requirements in the Ashland area is presented in Appendix I.

Ancillary Solid Wastes

Waste such as PPE, construction debris and other types of solid wastes generated during the conduct of remedial activities can be disposed of at a local municipal landfill. The quantity generated will depend on the remedial alternative. PPE will be evaluated and handled in accordance with USEPA guidance document to handle investigation derived waste (USEPA 2007).

Wood Waste

Under this alternative there is the potential for generating a substantial quantity of wood waste. The wood waste ranges in size from sawdust and chips to timber. Potentially, the larger debris could be burned as fuel at the NSP Bayfield Power Plant located in Ashland. Some additional maintenance at the plant would be required to accommodate the wood debris but this is considered a viable option at this time and will evaluated further during remedial design.

Monitoring

Monitoring options for this alternative would be the same as those listed in Section 8.3.2 with the exception of those elements relating to CDF or cap performance.

8.3.5.4 Cost

The total cost for this alternative is approximately $69,153,000. Cost elements are summarized in Table 8-7.

Table 8-7 - Cost Summary – Alternative SED-5: Dry Excavation.

Estimated Cost*		
Task	**SED-5A** Dry Excavation - No Treatment	**SED-5B** Dry Excavation - Thermal Treatment
Mob/Demob & Miscellaneous	$2,100,000	$2,500,000
Sediment Removal and Treatment	27,600,000	38,100,000
Water Removal and Treatment	7,800,000	7,800,000
Transport and Disposal	5,000,000	3,400,000
Long Term Monitoring	700,000	700,000
Total Estimated Cost	**$67,600,000**	**$82,000,000**

* Only Total Cost includes oversight and administration, engineering and contingency.
1: Sediment handling includes screening, dewatering, treatment and/or stabilizing if necessary

8.4 Detailed Analysis of Retained Remedial Action Alternatives – Sediment

In this section the retained alternatives are assessed against criteria specified in the NCP and USEPA guidance, as follows:

- **Threshold Criteria**
  - Overall protection of human health and the environment
  - Compliance with ARARs

- **Balancing Criteria**
  - Long-term effectiveness and permanence
  - Reduction of toxicity, mobility and volume through treatment
  - Short-term effectiveness
  - Implementability
  - Cost

- **Modifying Criteria (assessed after the public comment period)**
  - State and Agency Acceptance
  - Community acceptance

8.4.1 Threshold Criteria

Of the nine CERCLA-defined FS evaluation criteria, two criteria are threshold criteria and must be met by each remedial alternative to be considered applicable and appropriate for the remedy. These include:

- overall protection of human health and the environment; and
- compliance with ARARs.

8.4.1.1 Overall Protection of Human Health and the Environment

Protection of human health and the environment is based on an evaluation of each remedial alternative's ability to be protective of human health and the environment. The evaluation focuses on how a specific alternative achieves adequate protection, and how site risks are eliminated, reduced, or controlled. Unacceptable short-term or cross-media impacts are also evaluated, if present.

This evaluation criterion provides a final check to assess whether each alternative provides adequate protection of human health and the environment. The overall assessment of protection draws on the assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Evaluation of the overall protectiveness of an alternative should focus on whether a specific alternative achieves adequate protection and should describe how site risks posed through each pathway being addressed by the FS are eliminated, reduced, or controlled through treatment, engineering, or institutional controls. This evaluation also allows for consideration of whether an alternative poses any unacceptable short-term or cross-media impacts.

Although biota may be removed with sediments, all sediment alternatives otherwise are protective of human health and the environment because contaminated sediments are either isolated from exposure to humans or biota and/or they are removed from the environment. While there may be some potential differences in long term effectiveness regarding protection of human health and the environment amongst the sediment alternatives, these can be addressed through long term monitoring, maintenance of CDF or subaqueous cap and implementation of contingency plans, if necessary. Long term effectiveness is discussed in Section 8.4.2.1 and the potential differences in protection of human health and the environment in Section 8.5.1.

Alternative SED-5 presents a slightly greater risk to human health during project implementation due to the need to work behind the barriers that will be used to enclose and dewater the work area and keep it dewatered for the four year project schedule.

8.4.1.2 Compliance with ARARs and TBCs

Each remedial alternative is evaluated against ARARs to determine compliance. If there are ARARs that are not met by an alternative, either the alternative can not be selected or there may be a basis for justifying a waiver of the ARAR under CERCLA. The justification for a waiver should be discussed under this criterion.

A complete listing and discussion of ARARs and TBCs was presented in the ASTM. This evaluation criterion is used to determine whether each alternative will meet Federal and State ARARs (as defined in CERCLA Section 121) that have been identified in previous stages of the RI/FS process. The detailed analysis should summarize which requirements are applicable or relevant and appropriate to an alternative and describe how the alternative meets these requirements. When an ARAR is not met, the basis for justifying one of the six waivers allowed under CERCLA should be discussed.

<u>ARARs specific to Retained Alternatives</u>

Alternative SED-1 – No Action

There are no ARARs that pertain to the no-action alternative, since no action is taken.

Alternative SED-2 –CDF, Removal and MNR

Under Alternative SED-2, steps would be taken to minimize or eliminate potential exposure to impacted sediment by removing sediment where concentrations of PAH exceed the sediment PRG. ARARs and TBCs that would relate to this alternative include landfill siting requirements (Wisconsin Statutes Chapter 289), design requirements for construction of a CDF in water (NR 322), and permission from the State to build the CDF on state property. In addition, WDNR has indicated that this alternative would need approval from both the Governor and State Legislature

Aquatic CDF

Construction of an aquatic CDF would include the placement of fill material and some type of structure to contain the fill on the bed of Lake Superior. There are several available procedural mechanisms which might be used to authorize such fill and structure placement.

Section 30.12 permit: State of Wisconsin Statute Section 30.12 addresses the deposit of "any material" or placement of "any structure" upon the bed of any navigable waterway. Section 30.12 provides that approval may be given by WDNR via issuance of either a general or individual permit. Section 30.12 also recognizes that special authorization may be granted by the Wisconsin Legislature. In correspondence dated March 30, 2007, WDNR staff have advised their interpretation of Section 30.12 limits the agency's ability to issue permits that authorize deposits to "small amounts of incidental fill when associated with other structures." In a meeting on March 3, 2008 WDNR staff reconfirmed this position with respect to administrative rules enacted under the authority of Section 30.12. The language of Section 30.12 does not contain such a limitation on WDNR's authority and the Company does not agree that the agency's authority is so limited. Nor do the rules enacted under the authority of Section 30.12. To the extent that authorization under Section 30.12 might be deemed necessary but not available to an aquatic CDF, this statutory requirement may be pre-empted on the basis that it improperly "restricts the range of options available to the EPA." See, United States v. Denver, City and County Of, 100 F.3d 1509, 1512 (10^{th} Cir. 1996).

The procedural steps to obtain a permit under Wis. Stat. §30.12 are the same for this project as for any project for which an individual permit under Wis. Stat. Chapter 30 is sought. While exemptions and general permits are available for various projects and impacts, this summary describes the procedures that apply when the permit applicant seeks an individual permit. The procedures are spelled out in detail in Wis. Stat. §§30.208 and 30.209, and ch. NR 310, WAC and are summarized below:

1) While exemptions and general permits are available for various projects and impacts, this summary describes the procedures that apply when the permit applicant seeks an individual permit. The first step would be for the permit applicant to prepare an application to WDNR for issuance of a permit. In this case, the Company would be the permit applicant. The application form is available on the WDNR website and identifies the information required to be submitted.
2) The subsequent steps are spelled out in the statute and administrative rule and summarized as follows:
    a. WDNR staff reviews the permit application and informs the applicant within 30 days whether the application is complete. If the application is deemed incomplete, WDNR must notify the applicant why and what additional information is needed. There is no limit on the number of times the applicant may supplement or resubmit the permit application. Wis. Stat. §30.208(2) and NR 310.14.
    b. Within 15 days of making its determination that the application is complete, WDNR provides public notice and a 30-day public comment period during which an interested party may request a public informational hearing. The project applicant may also request that a public hearing be scheduled, or WDNR may

schedule a public hearing on its own if it determines there is a "significant public interest in holding a hearing"; in either of those cases the public notice will provide the date of the public hearing. If a public informational hearing is to be held, it must be held within 30 days of the date on which DNR gives public notice that there will be a hearing. Wis. Stat. §30.208(3) and NR 310.15 and .16.

c. Within 30 days after the public hearing, or if no hearing is held within 30 days of the 30-day comment period, WDNR is to render a decision on the permit application. That decision may be to issue, deny or modify the requested permit. Wis. Stat. §30.208(3) and NR 310.17.

d. If the permit is issued in its requested or modified form, a third party may challenge it in either or both of two ways: an administrative review via *contested case hearing* or a circuit court review via *petition for judicial review*. Wis. Stat. §30.209 and NR 310.18.

    i. *Contested case hearing*: The party who objects to an issued permit and seeks a contested case hearing must show that the activity may violate specific provisions of Chapter 30. If the hearing request shows that a stay is "necessary to prevent irreversible harm to the environment", the permit is stayed until WDNR denies the hearing request or the administrative law judge (ALJ) to whom the contested case hearing is assigned determines the stay is not necessary. WDNR is required to grant or deny the hearing request within 30 days and to provide written notice of its determination. Wis. Stat. §30.209(1m) and (2) and NR 310.18.

        1. If the hearing request is granted, the hearing must be completed within 90 days after the matter is referred from WDNR to the Division of Hearings and Appeals in the Department of Administration, unless the parties agree to an extension. In extraordinary circumstances, the ALJ may grant a one-time extension of up to 60 days to complete the hearing. Wis. Stat. §30.209(1m) and (2). The decision of the ALJ can be appealed to circuit court via petition for judicial review. Wis. Stat. §30.209(3) and NR 310.18.

        2. If the hearing request is denied, the permit is effective as issued. Wis. Stat. §30.209(1m) and NR 310.17(4).

    ii. *Petition for Judicial Review*: Issuance of the permit in requested or modified form would be considered a final agency action subject to review by the circuit court. The vehicle for this review is a petition for judicial review and must be filed within 30 days of the decision sought to be reviewed. A project opponent could chose this route following the contested case hearing or in lieu of the contested case hearing. Appeal from the circuit court's decision is to the Wisconsin court of appeals. Wis. Stat. §30.209(3) and NR 310.18.

e. If the permit is denied or issued in a modified form which is not satisfactory to the permit applicant, the permit applicant may also challenge that decision in either or both of the same two ways: contested case hearing or petition for judicial review. The key difference would be that the permit applicant's interest in the matter is recognized by law and, unlike a third party, the permit applicant is not required to identify how the permit fails to comply with specific provisions of Wis. Stat. Chapter 30. Wis. Stat. §30.209.

f. If the outcome of either a contested case hearing or a petition for judicial review is that the permit is denied or issued in a modified form not satisfactory to the permit applicant, the permit applicant may appeal that decision further or reapply. Wis. Admin. Code NR 310.17 and .18. If the outcome of a contested case hearing or a petition for judicial review is that the permit is issued, a project opponent may appeal that decision further. Appeal to the Wisconsin court of appeals is as of right; further appeal to the Wisconsin Supreme Court is a discretionary appeal.

The Company continues to disagree with WDNR's position that Wis. Stat. § 30.12 limits WDNR's ability to issue permits to deposits of "small amounts of incidental fill when associated with other structures." Our review of Wis. Stat. §30.12 and the Wisconsin Administrative Code provisions enacted under its authority lead to the following conclusions:

1) the statute does not specify any maximum volume or amount of fill or deposit that may be authorized by permit;
2) the rules identify certain activities that are exempt from the requirement to obtain a permit; in some cases, this exemption is based on the amount or volume of fill or deposit being less than a specified threshold;
3) the rules identify certain activities that are eligible for a general permit; in some cases, this eligibility is based on the amount or volume of fill or deposit being less than a specified threshold;
4) the rules authorize issuance of individual permits for fills and deposits;
5) the rules do not set a blanket maximum amount or volume or fill or deposit that may be authorized by individual permit;

Chapter NR 310, WAC provides the only other standards by which DNR is to consider an application for an individual permit to construct a CDF. Pursuant to NR 310.17(2), WAC, DNR "shall consider all the following information in deciding whether to approve, modify or deny an individual permit application:

(a) Applicable standards in statutes, rules and common law.
(b) Plans and information provided by an applicant.
(c) Information gathered during site investigations.
(d) Written or oral information provided during a public comment period or public hearing.
(e) Statements or information provided by local, state and national government agencies.
(f) Data or information found in natural resource inventories and plans, or maps collected by the department or others using commonly accepted methods.
(g) Published scientific research.
(h) Section 1.11, Stats., Wisconsin environmental policy act, and ch. NR 150.
(i) Any other pertinent information."

Nothing in these standards sets a specific limitation on the volume or amount of fill that may be authorized under Wis. Stat. § 30.12; nor do these standards authorize DNR to categorically deny an individual permit for a CDF simply because the proposed volume of material exceeds a certain threshold. Thus, we find no support for WDNR's position that individual permits issued under Wis. Stat. §30.12 or the rules enacted thereunder may only authorize "small" amounts of fill or deposit.

Legislative lake bed grant: We are aware of at least two aquatic CDFs that have been authorized in Wisconsin Great Lakes waters via legislative lake bed grant. Pursuant to its authority under Article IX, Section 1 of the Wisconsin Constitution, the Wisconsin Legislature may grant authority to utilize a portion of lake bed for purposes considered to be consistent with the public trust in those navigable waters. Such legislative lake bed grants have been made to authorize the CDF in the waters of Green Bay referred to as Renard (a/k/a Kidney) Island, and the CDF in the waters of Lake Michigan referred to as the Milwaukee Harbor CDF. Wisconsin Statute Section 13.097 provides that WDNR is to report to the Legislature the agency's view of whether the lake bed grant is consistent with protecting and enhancing a public trust purpose. A legislative lake bed grant can be made only to a municipality; thus, if this mechanism is used either the City of Ashland or the County of Bayfield would likely be designated as the lake bed grantee. Because a legislative lake bed grant is a form of legislative action, signature by the Governor would also be required.

Because the legislative lake bed grant is an act of the legislature, the procedural steps to obtain a legislative lake bed grant are the same procedural steps to enact any piece of legislation. They are summarized below:

1) The first step would be to identify a legislator or legislators who will request that a bill be drafted and who will sponsor the bill as legislation. Because the legislative grant would likely designate either the City of Ashland or the County of Bayfield as the lake bed grantee, identification of a legislator or legislators could be done by or in cooperation with either or both of those municipal entities.
2) The second step would be for the legislator or legislators to request the bill be drafted and, once drafted, to sponsor the bill for consideration by the full legislature. This step would include creating the legal description of the area to be included in the lake bed grant.
3) The third step would encompass the standard legislative process, from introduction of the bill, through the committee hearing stage, and to the floors of both the Senate and Assembly for consideration. This step might include responses to proposed amendments and testimony in support of the legislation from the bill's sponsors and other supporters. During this step, the report required of WDNR by Wis. Stat. §13.097 would be provided to and considered by the legislative committees.
4) The fourth step depends on the outcome of the legislature's consideration. If the legislature approves the bill, it would go to the Governor for signature. If the Governor signs it, it would become effective. If the legislature does not approve the bill or if the Governor does not sign it, then the bill sponsors would have the option of reintroducing the legislation in a future legislative session or abandoning the effort.

Board of Commissioners of Public Lands Lease: State of Wisconsin Statute Section 24.39 authorizes the Board of Commissioners of Public Lands (BCPL) to enter into long-term (50-year), renewable leases of submerged lake bed for various purposes, including "improvements to water navigation, construction of harbor facilities, and recreation." State of Wisconsin Statute Section 30.11(5) directs WDNR to advise BCPL of its view as to the consistency of the proposed lease and associated use with the public interest. The BCPL can enter into leases with either municipal or private parties; however, the lessee must be the riparian property owner. If this mechanism is used, the City of Ashland as riparian owner would likely be the lessee and such a lease may well be consistent with the City's harbor development plans. BCPL leases do not require legislative or gubernatorial approval.

Entering into a lease with the BCPL is similar to entering into a lease with any party, although in this case the party is a governmental entity. As a result the purposes for the lease must meet the statutory requirements. The procedural steps to obtain a lease from the BCPL are as follows:

1) The first step would be to identify the parties to the lease. Because the lease must be between the BCPL and the riparian property owner, the likely lessee in this case would be the City of Ashland. Lease negotiations could be conducted by or on behalf of the City, with whatever support from the company the City and BCPL deem appropriate.
2) The second step would be to establish the legal description of the area to be included in the lease. This may require that a survey be conducted; if so, the survey would be conducted by a credentialed survey company working on behalf of the City.
3) The third step would be to prepare a draft of the lease terms. The drafting could be done by staff of the BCPL or by representatives or designees working on behalf of the City, depending on the parties' preferences. The drafting would establish the area to be included in the lease, the purpose of the lease, the term of the lease, and any other conditions the parties agreed to and deemed necessary.
4) The fourth step would be for the BCPL to consider the proposed lease and whether its terms meet the requirements of Wis. Stat. §24.39(4). This step would require a meeting or meetings of the BCPL to consider the proposed lease; the BCPL meets on an as-needed basis so the timing of the meeting would depend on when the proposed lease was ready for consideration and any other internal meeting protocols the BCPL follows. As part of this step, the BCPL would receive and consider the advice required from WDNR by Wis. Stat. §30.11(5) as to WDNR's view of the consistency of the proposed lease and associated use with the public interest. Wis. Stat. §24.39(4)(c) prohibits the execution of a lease without a prior finding of WDNR that any "proposed physical change in the area contemplated as the result of the execution of any term lease is consistent with the public interest in the navigable waters involved."
5) The fifth step would be for the parties to execute the lease, if the BCPL approved the lease. The lease would become effective upon execution. If the BCPL does not approve the lease, the parties would have the option of negotiating other terms that the BCPL would approve, or of abandoning the effort.

In light of the number of mechanisms that might be utilized to authorize an aquatic CDF, it would be premature to eliminate this option or to deem it less viable than other options currently under consideration. Design specifications for the CDF would need to satisfy the substantive statutory, public interest and public trust requirements; however, it is possible that all of these mechanisms may be considered process ARARs and thus subject to the CERCLA § 121(e)(1) permitting exemption as the CDF would constitute an "on-site" remedy as defined in 40 CFR § 300.400(e)(1).

Upland CDF

As an alternative to an aquatic CDF, an upland CDF could be constructed. Wis. Stat. Ch. 289 authorizes DNR to regulate the siting, construction and operation of solid waste facilities. Pursuant to that authority, DNR has promulgated Wis. Admin. Code Ch. NR 504 entitled Landfill Location, Performance, Design and Construction Criteria. NR 504.04(3), WAC specifies the locational criteria applicable to a CDF located on the upland (above the ordinary high water mark). Included in the locational criteria in NR 504.04(3) are the requirements that the limits of fill of the facility be set back 1,000 feet from any navigable lake, 300 feet from any navigable stream, and be outside of the floodplain. NR 504.04(2) authorizes DNR to grant exemptions from the locational criteria, and specifically authorizes DNR to grant an exemption from the 1,000 foot setback from any navigable lake and the 300 foot setback from any navigable stream "upon demonstration by the applicant of circumstances which warrant an exemption." NR 504.04(2) specifies that exemptions may not be granted from the prohibition on locating a facility within the floodplain. This language appears to be based on the Wis. Stat. s. 289.35 which prohibits solid waste facilities within areas under the jurisdiction of shoreland and floodplain zoning regulations.

However, Wis. Stat. s. 289.35 goes on to specifically provide that DNR "may issue permits authorizing facilities in such areas."

The procedural steps to obtain an exemption from the locational criteria for an upland CDF are as follows:

1) The first step would be to prepare an initial site report for siting of a solid waste facility following the procedural steps provided in Wis. Stat. §289.21(1) and Wis. Admin. Code NR 509 and to obtain an initial site report opinion from WDNR.
2) The second step would be to provide notice to each affected municipality of the proposal for the solid waste facility, to request the municipality identify any applicable local approvals, and to apply for those local approvals as provided in Wis. Stat. §289.22 and NR 512.06.
3) The third step would be to prepare a feasibility report for siting a solid waste facility following the procedural steps provided in NR 512.06. The feasibility report would include the request for exemption from the locational criteria as provided in NR 512.05. The request for exemption would include an explanation of the "circumstances that warrant" the exemption as called for by NR 504.04(2)(b).
4) The fourth step would be WDNR's review of the feasibility report.

a) This step would include WDNR's determination as to when the feasibility report is complete and public notice of that determination with the opportunity for public comment and hearing. Included in this step would be the opportunity for either an informational or contested hearing. A request for an informational hearing must be filed within 30 days of the public notice and the hearing must be held within 60 days of the close of the 30-day public comment period. Subject to certain showings, if so requested the hearing may be treated as a contested case hearing. In that case, the hearing must be held within 120 days of the close of the 30-day public comment period and the decision issued within 90 days of the close of the hearing.

b) This step also would include WDNR's evaluation of whether the "circumstances warrant" the requested exemption under the provisions of NR 504.04(2)(b). That decision by WDNR is also subject to review during the public informational or contested case hearing, if either is held.

5) The fifth step would be the decision to grant or deny the exemption. If no hearing is held or if a public informational hearing is held and WDNR determines that the exemption can be granted, then WDNR will grant the exemption as part of its feasibility report approval. Wis. Stat. §289.29(3). If a contested case hearing is held, then the Administrative Law Judge will issue the final determination of feasibility including the decision on any requested exemptions. Wis. Stat. §289.27(4). The decision to grant or deny the exemption is challengeable by the project applicant or a third party under the provisions of Wis. Stat. Ch. 227 via either contested case hearing, if one has not been held, or petition for judicial review to the circuit court. Those decision are further appealable as described above.

While the location of an upland CDF would not be determined until the Remedial Design stage, the statute and the applicable administrative rules provide DNR authority to issue permits authorizing facilities within a floodplain and to grant exemptions from the 1000 foot setback from a navigable lake. The requirements to seek and obtain local approvals are clearly process ARARs, and the procedural steps to submit and obtain feasibility report are equally subject to the CERCLA § 121(e)(1) permitting exemption as the CDF would constitute an "on-site" remedy as defined in 40 CFR § 300.400(e)(1). Thus, these locational requirements are not an impediment to placement of an upland CDF and do not provide a basis for eliminating this option from consideration.

Additional action may be required to meet air and surface water quality during dredging and dewatering operations. Furthermore, wetlands mitigation may be necessary as part of this alternative. In addition to the ARARs and TBCs described above, the design of sediment removal process and CDF needs to have U.S. Army Corps of Engineers concurrence.

Upon proper implementation of this alternative, ARARs would be met.

Table E-3 in Appendix E summarizes the ARARs and TBCs that affect implementation of Alternative SED-2.

Alternative SED-3 – Removal, Treatment, Disposal, Capping, and MNR

Under Alternative SED-3, steps would be taken to minimize or eliminate potential exposure to impacted sediment by removing sediment to a depth of four feet where concentrations of PAH exceed the sediment PRG. Sediment removed would be dewatered and treated on site using thermal treatment, or dewatered and sent off site for disposal in a landfill. Sediment located outside of the capped area with concentrations of PAH greater than 9.5 ug PAH/g dwt at 0.415% OC would be monitored. Alternative SED-3 would be similar to Alternative SED-2 with respect to ARARs. As with Alternative SED-2, WDNR has indicated that this alternative would need approval from both the Governor and State Legislature.

A subaqueous cap probably would also be considered a structure and fill on the bed of Lake Superior and would be subject to the same ARARs as Alternative SED-2. As with Alternative SED-2 there are several available procedural mechanisms which might be used to authorize such fill and structure placement. These are discussed in the previous section. In this regard, we are aware that USEPA and WDNR have proposed a ROD change for the Fox River NPL Site that includes capping of sediment in navigable waters. It is possible the mechanism upon which this decision is based can be used for the Ashland Site.

In addition, consideration of requirements for high-temperature thermal desorption units may be required (NR 400 through 499) if it is determined that the sediment needs to be decontaminated. Dewatering would be subject to WPDES requirements (NR 200 and NR 220 through 297). In addition to the ARARs and TBCs described above the design of sediment removal process and the subaqueous cap needs to have U.S. Army Corps of Engineers concurrence. Upon proper implementation of this alternative, ARARs would be met.

Table E-3 in Appendix E summarizes the ARARs and TBCs that affect implementation of Alternative SED-3.

Alternative SED-4 – Removal, Treatment, Disposal and MNR

Under Alternative SED-4, steps would be taken to minimize or eliminate potential exposure to impacted sediment by removing sediment where concentrations of PAH exceed the sediment PRG Sediment removed would be dewatered and treated on site using thermal treatment, or dewatered and sent off site for disposal in a landfill. Treated sediment would be sent off site for beneficial reuse. Alternative SED-4 would be similar to Alternative SED-3 with respect to ARARs. In addition to the ARARs and TBCs described above the design of sediment removal process needs to have U.S. Army Corps of Engineers concurrence.

Table E-3 in Appendix E summarizes the ARARs and TBCs that affect implementation of Alternative SED-4.

Alternative SED-5 – Dry Excavation, Treatment, Disposal and MNR

Alternative SED-5 would be similar to Alternative SED-4 with respect to ARARs.

8.4.2 Balancing Criteria

Five of the remaining criteria are referred to as balancing criteria by which the alternatives are compared and upon which the analysis is based. These include:

- long-term effectiveness and permanence:
- reduction of toxicity, mobility, or volume;
- short-term effectiveness;
- implementability; and
- cost

8.4.2.1 Long Term Effectiveness and Permanence

Each remedial alternative is evaluated as to magnitude of long-term residual risks, adequacy of controls, and reliability of long-term management controls in restoring impacted site media. Table 8-8 presents an evaluation of the long-term effectiveness and permanence of each alternative.

Table 8-8. Evaluation of Long-term Effectiveness and Permanence for Potential Remedial Alternatives for Sediment

Alternative	Magnitude and Type of Residual Risk	Adequacy and Reliability of Controls
Alternative SED-1: No Action	Potential risk to human health or the environment, if any, would not be reduced.	There are no remedial actions or controls associated with this alternative.
Alternative SED- 2: CDF, Removal, and MNR	Risk to human health and the environment would be reduced through covering impacted material above the sediment PRG or placement of impacted sediment above the sediment PRG into the CDF area, and covering the CDF by placing clean material over the impacted sediment to prevent human contact and impact to biota. Monitoring would evaluate the effectiveness of the CDF in containing contaminated sediments and the effect of natural recovery processes that could result in reduction of COPC concentrations outside of the CDF footprint.	Alternative SED-2 would involve technologies that have been used previously, and whose adequacy and reliability have been tested (See Table 1 in Attachment 3 in Appendix A2 (previously provided as Attachment 3 to the Comparative Analysis of Alternatives Technical Memorandum which provides an overview of the state of the practice in use of CDFs for containment of contaminated sediments). Control measures would be required when dredging and placing sediment into the CDF area to prevent or minimize transport of sediment outside of the area of concern. Similarly, impacts to air quality could occur, and may need to be addressed to prevent exposure to workers and downwind receptors. Placing clean material over the CDF would prevent exposure to sediment, and minimize on-going release of volatiles to water and air. Long-term monitoring would be required to evaluate the effectiveness of the CDF in preventing exposure to contaminants and containment of contaminated sediments.
Alternative SED-3: Removal, Treatment and/or Disposal, Capping, and MNR	Risk to human health and the environment would be reduced through removal of impacted sediment to allow sufficient draft to construct a cover, and constructing a cap over the remaining impacted sediment to prevent human contact and impact to biota. Removed sediment would be treated on-site and/or disposed off-site, thereby eliminating any potential risk associated with the sediment. Monitoring would evaluate on-going risk to human health and the environment from failure of the cap as well as the effect of natural recovery processes that could result in reduction of COPC concentrations beyond the cap area.	Alternative SED-3 would involve use of technologies that are proven reliable and accepted, including dredging, sediment capping, and treatment of sediment through incineration or thermal destruction, and off-site disposal. EPA's Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (USEPA 2005) discusses that subaqueous capping has been selected as a remedy or component of the remedy at over 15 Superfund sites. Capping has also been used at sites where there is NAPL in the sediments such as at the McCormick and Baxter Superfund Site in Oregon where approximately 20 acres of creosote containing sediment were capped. Control measures would be required to ensure that exposure is limited during sediment removal, dewatering, treatment, and transport activities. These control measures could include placement of silt curtains and sorbent booms,

Table 8-8. Evaluation of Long-term Effectiveness and Permanence for Potential Remedial Alternatives for Sediment

Alternative	Magnitude and Type of Residual Risk	Adequacy and Reliability of Controls
		and if necessary temporary sheet piling, during dredging operations, vapor recovery during dewatering and treatment operations, and special handling of waste, if necessary, during transport for disposal. Monitoring would be required to evaluate the long-term effectiveness of these measures in preventing unacceptable exposure and risk.
Alternatives SED-4 and SED-5: Removal (by dredging or excavation), Treatment and/or Disposal and MNR	Risk to human health and the environment would be reduced through removal of impacted sediment, thereby preventing human contact and impact to biota. Since sediment removed would be treated on site and disposed off site, any potential risk associated with the sediment would be effectively eliminated. Monitoring would evaluate on-going risk to human health and the environment from impacted sediment that remains in place.	Alternatives SED-4 and SED-5 would involve use of technologies that are proven reliable and accepted, including dredging, treatment of impacted sediment through incineration or thermal destruction, and off-site disposal. Control measures would be required to ensure that exposure is limited during sediment removal, dewatering, treatment, and transport activities. These control measures could include placement of silt curtains and sorbent booms and if necessary temporary sheet piling, during dredging operations, vapor recovery during dewatering and treatment operations, and special handling of waste, if necessary, during transport for disposal. If properly implemented, there would be little risk associated with implementation of this alternative. Monitoring would be required to evaluate the long-term effectiveness of these measures in preventing unacceptable exposure and risk.

8.4.2.2 Reduction of Toxicity, Mobility or Volume through Treatment

The remedial alternatives are evaluated for permanence and completeness of the remedial action in significantly reducing the toxicity, mobility, or volume of hazardous materials through treatment. Each alternative is evaluated based on the treatment processes used, the volume or amount and degree to which it destroys or treats hazardous materials; the expected reduction in toxicity, mobility, or volume provided by the alternative; the extent to which the treatment is irreversible; and the types and quantities of residuals that will remain following treatment. Table 8-9 presents a summary of this evaluation.

Table 8-9. Evaluation of Reduction of Toxicity, Mobility, or Volume through Treatment for Potential Remedial Alternatives for Sediment

Alternative	Treatment Process Used and Materials Treated	Volume of Material Destroyed or Treated	Degree of Expected Reductions	Degree to Which Treatment is Irreversible	Type and Quantity of Residuals Remaining
Alternative SED-1: No Action	No treatment process used.	None.	None.	Not applicable.	No treatment, therefore all residuals remain.
Alternative SED-2: CDF, Removal, and MNR	Auxiliary treatment for water will be necessary prior to discharge.	None treated, although over 74,000 cy of material would be placed and contained within CDF. Approximately another 60,000 cy would be covered by CDF. There would be no reduction in volume.	None, although exposure to contaminants is eliminated by containment within CDF.	Treatment via construction of a CDF would be nearly completely reversible.	No treatment, therefore all residuals remain; however, these residuals do not pose a risk to humans or biota as direct contact is effectively eliminated and the contaminated sediments are contained in a CDF.
Alternative SED-3: Removal, Treatment and/or Disposal, Capping, and MNR	Impacted sediment that is removed would be treated by thermal desorption or incineration, or shipped off-site for disposal.	Approximately 78,000 cubic yards of material would be removed, treated and disposed.	Destruction efficiency of thermal treatment is anticipated to be 99% or more; material that remains in place would be effectively contained thereby eliminating risk to human heath and biota; material shipped off site for disposal would be effectively contained, thereby eliminating exposure.	Thermal destruction is permanent and irreversible; theoretically, untreated sediment that is sent for off-site disposal could present potential risk; however, this scenario is unlikely.	Approximately 50,000 cubic yards of impacted material would remain in place; however, this material would be capped, thereby effectively eliminating risk to human health and biota.
Alternatives SED-4 and SED-5: Removal (by dredging or excavation), Treatment and/or Disposal and MNR	Impacted sediment that is removed would be treated by thermal desorption or incineration, or shipped off-site for disposal.	Approximately 134,000 cubic yards of material would be removed, treated and disposed.	Destruction efficiency of thermal treatment is anticipated to be 99% or more.	Thermal destruction is permanent and irreversible.	Under this alternative, impacted sediment with PAH concentrations greater than the sediment PRG would be removed, thereby effectively eliminating risk to human health and biota.

8.4.2.3 Short Term Effectiveness

The evaluation of short-term effectiveness is based on the degree of protectiveness of human health achieved during construction and implementation of the remedy. Potential implementation risks to the community and site workers and mitigation measures for addressing those risks are included in this evaluation. In addition, environmental impacts during implementation and the time required to achieve the RAOs must also be considered in the evaluation of this criterion. Table 8-10 summarizes the results of this evaluation.

Table 8-10. Evaluation of Short Term Effectiveness for Potential Remedial Alternatives for Sediment

Alternative	Protection of Community and Workers During Remediation	Environmental Impacts of Remedy	Time Until RAOs are Achieved
Alternative SED-1: No Action	Since no remediation is occurring, no protection of community and workers is necessary.	Since no remediation is occurring, there would be no additional impact to the environment over current impacts.	RAOs would not be achieved in the foreseeable future, and are unlikely to be met within 30 years.
Alternative SED-2: CDF, Removal, and MNR	Worker and community protection would be required and controls would need to be implemented during dredging, placement and dewatering of sediment and construction of the CDF.	Dredging and dewatering activities could release volatiles from sediment into surface water and air, thus impacting surface water and air quality. Dredging could agitate sediments, which could lead to resuspension and dispersal. It is unlikely that nearby residents will experience increased exposure to VOCs during dredging and on-shore sediment treatment operations because under this alternative only sediments with low levels of VOCs and PAHs are dredged and treated.	It is anticipated that RAOs would be reached upon completion of the CDF; based on current volume estimates, it is anticipated to be completed within two years from project start.
Alternative SED-3: Removal, Treatment and/or Disposal, Capping, and MNR	Worker and community protection would be required and controls would need to be implemented during dredging, placement and dewatering of sediment and construction of the cap.	Dredging and dewatering activities could release volatiles from sediment into surface water and air, thus impacting surface water and air quality. Dredging could also agitate sediments, which could lead to resuspension and dispersal. . Nearby residents may experience increased exposure to VOCs during dredging and onshore sediment treatment operations. Thermal treatment has the potential to release VOCs into the air during start-up or pilot operations until the unit is operating at optimal efficiency. If sediment is disposed off site without treatment at a NR500 landfill there would be no future exposure to humans or biota because site access is controlled.	It is anticipated that RAOs would be reached upon completion of the cap and completion of thermal treatment; based on current volume estimates, it is anticipated to be completed within three years from project start.
Alternatives SED-4 and SED-5: Removal (by dredging or excavation), Treatment and/or Disposal and MNR	Worker and community protection would be required and controls would need to be implemented during dredging, dewatering, and treatment.	Dredging or excavation and dewatering activities could release volatiles from sediment into surface water and air, thus impacting surface water and air quality. Dredging could also agitate sediments, lead to resuspension and dispersal. Nearby residents may experience increased exposure to VOCs during dredging or excavation and onshore sediment treatment operations. This duration of this potential exposure would be twice as long with SED-5 (approx. 4 years) as with SED-4 or other alternatives. Thermal treatment has the potential to release VOCs into the air during start-up or pilot operations until the unit is operating at optimal efficiency. If sediment is disposed off site without treatment, landfill there would be no future exposure to humans or biota because site access is controlled.	It is anticipated that RAOs would be reached upon completion of the dredging and thermal treatment; based on current volume estimates, it is anticipated to be completed within three years from project start.

8.4.2.4 Implementability

Implementability is based on the evaluation of technical feasibility, administrative feasibility, and the availability of services and materials. Technical feasibility considers the following factors:

- difficulties that may be inherent during construction and operation of the remedy;
- the reliability of the remedial processes involved;
- the flexibility to take additional remedial actions, if needed;
- the ability to monitor the effectiveness of the remedy;
- the availability of offsite treatment, storage, and disposal facilities; and,
- the availability of needed equipment and specialists.

Administrative feasibility considers permitting and regulatory approval and coordination with other agencies. Table 8-11 presents a summary of this evaluation.

Table 8-11. Evaluation of Implementability for Potential Sediment Remedial Alternatives

Alternative	Technical Feasibility	Reliability of Technology	Administrative Feasibility	Availability of Services and Materials
Alternative SED-1: No Action	There would be no technical issues associated with this alternative. The ability to complete additional investigation or remedial measures would not be prevented by this alternative.	Not applicable, since no technology is implemented. No monitoring would be conducted.	There would be no administrative issues related to the no-action alternative.	No services or materials would be needed for this alternative.
Alternative SED-2: CDF, Removal, and MNR	The technical aspects of this alternative, including dredging, placement and dewatering of sediment, and construction of a CDF, are all feasible technologies. Implementation of this alternative would not prevent completion of additional investigation or remedial measures. However, significant effort would be required to access impacted sediment in the CDF for additional evaluation or remediation. Installation of a sheet pile through the wood waste layer might be difficult.	The technologies and process options used as part of this alternative have been used elsewhere with success. See Table 1 to Attachment 3 in Appendix A2 which was previously provided as Attachment 3 to the Comparative Analysis of Alternatives Technical Memorandum. Monitoring would allow accurate evaluation of effectiveness of remedial action through collection of samples outside and within the CDF to compare concentrations with pre-remedial action levels.	Administrative issues related to implementation of this alternative would include complying with ARAR requirements for dredging and construction of a CDF in navigable waters. According to WDNR, this alternative would need approval by the State Legislature and Governor, thus potentially making administrative implementability difficult.	Services necessary for this alternative are readily available and proven technologies. Companies that perform dredging, sheet-pile installation, and cover construction are located in relatively close proximity to the site.
Alternative SED-3: Removal, Treatment and/or Disposal, Capping, and MNR	The technical aspects of this alternative, including dredging, dewatering, treatment, and construction of a subaqueous cap, are all feasible technologies. Implementation of this	The technologies and process options used as part of this alternative have been used elsewhere with success. Monitoring would allow accurate evaluation of	Administrative issues related to implementation of this alternative would include complying with ARAR requirements for dredging and construction of a cap in	Services necessary for this alternative are readily available and proven technologies. Companies that perform dredging, sheet-pile installation, and sub-aqueous cap

Table 8-11. Evaluation of Implementability for Potential Sediment Remedial Alternatives

Alternative	Technical Feasibility	Reliability of Technology	Administrative Feasibility	Availability of Services and Materials
	alternative would not prevent completion of additional investigation or remedial measures. However, significant effort would be required to access impacted sediment under the cap for additional evaluation or remediation.	effectiveness of remedial action through collection of samples to compare concentrations with pre-remedial action levels.	navigable waters, as well as operation of a treatment system at the site. According to WDNR, this alternative would need approval by the State Legislature and Governor, thus potentially making administrative implementability difficult.	construction are located in relatively close proximity to the site. Thermal treatment units are transportable and can be readily transported to the site.
Alternatives SED-4 and SED-5: Removal (by dredging or excavation), Treatment and/or Disposal and MNR	The technical aspects of this alternative, including dredging or excavation, dewatering, treatment, and off-site disposal, are all feasible technologies. Implementation of this alternative would not prevent completion of additional investigation or remedial measures. Alternative SED-5 is more difficult to implement because it requires installation of safe and watertight enclosures that would have to be maintained for the anticipated four year project schedule.	The technologies and process options used as part of this alternative have been used on many contaminated sediment sites with success.	Administrative issues related to implementation of this alternative would include o complying with ARAR requirements for dredging as well as operation of a treatment system at the site. Furthermore, additional administrative actions could be required to meet the intent of ARARs.	Services necessary for this alternative are readily available and proven technologies. Companies that perform dredging and excavation, and thermal treatment are located in relatively close proximity to the site. Thermal treatment units are transportable and can be readily transported to the site.

8.4.2.5 Cost

For each remedial alternative, estimated capital and O&M were prepared in accordance with the USEPA guidance document *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (USEPA and USACE 2000). The cost estimates are developed primarily for the purpose of comparing remedial alternatives and not for establishing project budgets. The estimating process provides costs that are within a range of 30-percent below to 50-percent above expected actual costs, consistent with USEPA guidance. Present worth analyses were performed for long-term costs using 30-year O&M period and a 7-percent discount rate.

Table 8-12 presents a summary of the cost evaluation for all alternatives evaluated. The details of these costs are presented in Appendix F3 Tables F3-1 through F3-12.

Table 8-12. Cost Summary of for Potential Remedial Alternatives for Sediment.

Alternative	Estimated Cost	Included Transportation & Disposal Costs
Alternative SED-2 - CDF	$ 37,000,000	N/A
Alternative SED-3A – Mechanical Dredge, Cap, No Treatment	$ 30,100,000	$ 2,700,000
Alternative SED-3B - Mechanical Dredge, Cap, Thermal Treatment	$ 34,500,000	$ 1,800,000
Alternative SED-3C – Hydraulic Dredge, Cap, No Treatment	$ 36,400,000	$ 2,700,000
Alternative SED-3D – Hydraulic Dredge, Cap, Thermal Treatment	$ 41,700,000	$ 1,800,000
Alternative SED-4A - Mechanical Dredge, No Treatment	$ 41,300,000	$ 4,600,000
Alternative SED-4B - Mechanical Dredge, Thermal Treatment	$ 48,900,000	$ 3,000,000
Alternative SED-4C – Hydraulic Dredge, No Treatment	$ 51,600,000	$ 4,400,000
Alternative SED-4D – Hydraulic Dredge, Thermal Treatment	$ 61,100,000	$ 3,000,000
Alternative SED-5A – Dry Excavation, No Treatment	$67,600,000	$5,000,000
Alternative SED-5B – Dry Excavation, Thermal Treatment	$82,000,000	$3,400,000

Note: The cost of a NR500 landfill sited in Ashland is approximately $18,100,000 including loading and transportation of sediment and soil. If this were selected as an alternative because of lack of capacity at other existing NR 500 landfills or for other cost benefit reasons, the majority of transport and disposal costs in the above estimates would be avoided. In addition, thermal treatment costs may be avoided for alternatives 3B, 3D, 4B, 4D and 5B.

8.4.3 Modifying Criteria

The third group, the *modifying criteria*, includes:

- State/Support agency acceptance; and
- Community acceptance.

As previously discussed, these last two criteria are typically formally evaluated following the public comment period, although they can be factored into the identification of the preferred alternative to the extent practicable.

With regard to community acceptance criterion, it should be noted that the agencies conducted an outreach session consisting of a “community workshop” in Ashland on October 25, 2007. A summary of that workshop provided by USEPA is included as Appendix C.

8.5 Comparative Analysis of Retained Remedial Alternatives – Sediment

In this section, as required by CERCLA and NCP guidance a comparative evaluation is conducted. The advantages and disadvantages of the alternatives will be concurrently assessed with respect to each criterion. The criteria considered as part of this comparative evaluation were discussed in Section 8.2. Table 8-13 presents a summary of the comparative analysis.

Table 8-13. Summary of Comparative Analysis for Potential Sediment Remedial Alternatives.

Criteria	Alternative SED-1: No Action	Alternative SED-2: Consolidation, CDF, and Monitoring	Alternative SED-3: Removal, Capping, Treatment and/or Disposal, and Monitoring	Alternative SED-4: Dredging, Treatment and/or Disposal, and Monitoring	Alternative SED-5: Dry Excavation, Treatment and/or Disposal, and Monitoring
Overall Protection of Human Health and the Environment	Low	High	High	High	High
Compliance with ARARs and TBCs	Low	High	High	High	High
Long-term Effectiveness and Permanence	Low	Moderate	Moderate to High	High	High
Reduction of Toxicity, Mobility and Volume through Treatment	Low	Moderate	Moderate	High	High
Short-term Effectiveness	High	High	Moderate	Low	Low
Implementability – Technical Difficulty*	Easy	Moderate	High	High	Very High
Implementability – Administrative Difficulty*	High	High	High	Moderate	Moderate
Cost	Low	High	High	High	Very High

* For implementability the least administratively or technically feasible are assigned the highest rating.

8.5.1 Overall Protection of Human Health and the Environment

Alternative SED-1 – No Action – offers the least protection of human health and the environment, as no additional actions would be taken to address site issues.

Alternative SED-2 – CDF – assures protection of human health and the environment by eliminating access to impacted sediment. Under this alternative, there is no destruction of COPCs, but these materials are permanently contained and inaccessible to humans or biota, thereby reducing risk. Attachment 3 to the Comparative Analysis of Alternatives Technical Memorandum (Appendix A2) discusses the state of the practice for use of CDFs for containment of contaminated sediment.

Alternative SED-3 – subaqueous capping of a portion of the sediment and removal of the remainder – is also protective of human health and the environment, because it isolates a portion of the sediment above the sediment PRG from exposure to humans or biota. The remaining sediment above the sediment PRG is removed. If that portion is thermally treated it reduces its volume and permanently eliminates its toxicity by treatment. If the sediment were to be sent for disposal without treatment, then this alternative reduces in situ volume and eliminates exposure to humans and biota by transfer of these materials to an environment where access is controlled. There is no reduction in toxicity if the sediment that is removed is disposed in a landfill although because access would be controlled there would be no exposure to humans or ecological receptors.

Alternative SED-4 – removal – is also protective of human health and the environment if the sediment is treated, because it results in decontamination of sediment above the PRG and removes it from the aquatic environment. If the sediment were to be sent for disposal without treatment, then this alternative would be roughly equivalent to Alternatives SED-2 and SED-3 (if Alternative SED-3 were also completed without sediment treatment); there would be no reduction in toxicity, but exposure to humans and biota is eliminated because access is controlled. There is no reduction in toxicity if the sediment that is removed is disposed in a landfill although because access would be controlled there would be no exposure to humans or ecological receptors.

Alternative SED-5 – dry excavation – is protective of human health and the environment if the sediment is treated, because it results in decontamination of sediment above the PRG and removes it from the aquatic environment. If the sediment were to be sent for disposal without treatment, then this alternative would be roughly equivalent to Alternatives SED-2 and SED-3 (if Alternative SED-3 were also completed without sediment treatment); there would be no reduction in toxicity, but exposure to humans and biota is eliminated because access is controlled. There is no reduction in toxicity if the sediment that is removed is disposed in a landfill although because access would be controlled there would be no exposure to humans or ecological receptors.

Since the project duration is anticipated to be twice that of the other sediment alternatives (approximately four years) the potential for volatilization of VOCs and exposure to residents is greater. In addition, it would preclude use of the Kreher Park for approximately two years longer than the other sediment alternatives.

8.5.2 Compliance with ARARs and TBCs

Alternative SED-1 would not comply with regulations. Alternatives SED-2, SED-3, SED-4 and SED-5 would be similar with respect to meeting ARARs and TBCs, as engineering and construction actions would be developed and completed in compliance with federal and state regulations.

8.5.3 Long-term Effectiveness and Permanence

Alternative SED-1 would not provide any long-term benefit, as any potential risk associated with impacted sediment is not eliminated through remedial action. The risk posed by the COPCs in sediment remains the same under Alternative SED-1.

Although there is no reduction in volume or toxicity of the contaminated sediment, Alternative SED-2 still provides a moderate level of permanence and effectiveness over the long term. Since no sediment is treated, the toxicity of the material remains the same, however accessibility and exposure to humans and biota is eliminated through containment.

Alternative SED-3 provides a high level of long term effectiveness and permanence for that sediment which is removed and treated. For the contaminated sediment that is capped there is no destruction of COPCs, but these materials are permanently contained and inaccessible to humans or biota, thereby reducing risk. A volume of approximately 78,000 cy would be permanently removed from the environment. If the sediment that is removed is not treated but disposed in an NR500 landfill exposure to humans and biota is eliminated through access restrictions.

Alternatives SED-4 and SED-5 would provide the highest effectiveness and permanence over the long term due to the permanent removal of the largest volume of sediment. If treated, thermal treatment of the sediment would eliminate toxicity, reduce volume and is permanent. If the sediment that is removed is not treated but disposed in an NR500 landfill, exposure to humans and biota is eliminated through access restrictions.

8.5.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative SED-1 offers no reduction in toxicity, mobility, or volume through treatment, as no action is taken.

Alternative SED-2 would permanently reduce the mobility of contaminated sediments, although the toxicity and volume would not change. While there is no destruction of COPCs, these materials are permanently contained and inaccessible to humans or biota, thereby reducing risk.

Alternative SED-3 would reduce toxicity, mobility and volume of approximately 78,000 cy of sediment which would be permanently removed from the environment. That sediment remaining under the cap would have permanently reduced mobility and since it would be inaccessible to humans or biota, it would eliminate exposure and risk. The inherent toxicity of that sediment remaining under the cap would not be reduced.

Alternatives SED-4 and SED-5 would have the greatest degree of reduction of toxicity, mobility, and volume of impacted material. Mobility would be reduced by permanently containing it in an NR500 landfill. Likewise, toxicity would be reduced since exposure to humans and biota would be eliminated because access in an NR500 landfill is controlled.

8.5.5 Short-term Effectiveness

Alternative SED-1 would have the least short-term impact on human health and the environment, as impacted sediment would not be disturbed, thereby potentially releasing COPCs into surface water and air. Of the three active remedial options, Alternative SED-2 would have the least short-term impact, as sediment is not brought to shore for dewatering or treatment, but is disposed in a CDF, a portion of which is subaqueous. Adequate controls would be in place to ensure worker and community safety during remedial activities. All other alternatives would have the potential of some short term risk from release of volatile emissions during debris removal and onshore dewatering and/or treatment. Release of volatile emissions from land-based activities including filling of a CDF could be better controlled than for dredging activities.

8.5.6 Implementability

Implementation of Alternative SED-1 would be easy, as no action would be performed. In addition, because no remedial action would occur, there would be no difficulty in implementing additional remedial actions at a later date.

Alternative SED-2 would be more difficult to implement than Alternative SED-1. The technology and equipment that would be used for this alternative is readily available, and has proven to be reliable at other similar sites. However, because WDNR has indicated that the Governor and Legislature must approve Alternatives SED-2 and SED-3, obtaining authorization to proceed may be problematic. Long term monitoring, included as a part of Alternatives SED-2, SED-3, and SED-4, would allow periodic evaluation of risks associated with materials left in place.

Alternatives SED-3 and SED-4 would be still more difficult to implement, as additional equipment, technology, and permitting would be required to perform the dewatering, thermal treatment, and disposal of sediment as well as for implementation of engineering controls for volatilization. Furthermore, the capping component included as part of Alternative SED-3 would add additional complexity to the implementation of this alternative.

Alternative SED-5 would be much more difficult to implement because of the need to install safe and watertight enclosures that would have to be maintained for the anticipated four year project duration. A contingency of 25% was used for this alternative compared to 20% for other sediment alternatives.

8.5.7 Cost

Alternatives SED-1 would be the lowest cost alternative.

The cost for Alternative SED-2 would be greater than costs for Alternative SED-1 and SED-3 if construction of the CDF is required to meet ch. NR 504, WAC specifications and armouring to the top of the sheet pile is required on the lakeside. The cost to implement SED-4 is approximately 30 to 50 percent greater than SED-2 and SED-3 depending upon whether the sediment is mechanically or hydraulically dredged and whether it is thermally treated. Cost for implementation of Alternative SED-5 would range between approximately $67,600,000 and $82,000,000 depending upon whether the sediment is thermally treated. This is more than twice the cost of most other alternatives.

Alternative capping designs, for instance a three foot cap (two feet of sand and one foot of rock for erosion control) with a carbon mat (three foot of sand and one foot of rock) would be several million dollars less than the four foot cap upon which the cost estimates for SED-3 is based. Based upon the treatability studies, a thinner cap with a carbon mat would be just as effective in isolating contaminants as the four foot cap upon which the cost estimate for SED-3 is based. An 11 acre carbon mat was placed without any difficulty at the Stryker Bay site.

8.5.8 Summary

For sediment, Alternative SED-1, while costing little to nothing, would not provide any long-term protection, and therefore should not be considered. Alternative SED-2 would provide the most long-term benefit with the fewest short-term technical implementation issues and short term impacts of remedy (due to volatilization) issues. However there would be permanent loss of approximately seven acres of shallow lake bed habitat. WDNR has also indicated that the Governor and Legislature would have to approve this alternative, thus making administrative implementability problematic.

With Alternative SED-3 approximately 78,000 cubic yards would be removed from the environment and either treated or disposed in a NR500 landfill. However, a subaqueous cap at the shoreline may be considered by some to be less permanent than a CDF. In addition the requirement for more debris removal and for sediment treatment as compared to SED-2 increases the short term risk of implementation of this alternative due to the likelihood that these activities would result in release of potentially harmful volatile emissions. As with Alternative SED-2, WDNR has indicated that the Governor and Legislature would have to approve this alternative, thus making administrative implementability more problematic, although no lake bottom would be lost since the top of the cap would be designed to provide a fully functioning benthic habitat with exactly the same bathymetry that presently exists.

Alternative SED-4 would offer greater protection of human health and the environment than Alternatives SED-2 and SED-3, but at a cost that is 30 percent or greater than Alternatives SED-2 and SED_3. If all dredging is conducted mechanically and there is no need for thermal treatment Alternative SED-4 is approximately $11,000,000 greater than Alternative SED-3 ($41,300,000 versus $30,100,000). However if hydraulic dredging is required and there is a need to thermally treat the sediments the cost for Alternative SED-4 could be as much as $20,000,000 greater than Alternative SED-3 ($61,100,000 versus $41,700,000) In addition the requirement for substantially greater debris removal and for treatment of almost twice as much sediment under Alternative SED-3 results in this alternative having the greatest short term risk of implementation due to the likelihood that these activities would result in release of potentially harmful volatile emissions. Unlike Alternatives SED-2 and SED-3, Alternative SED-4 does not have to be approved by the Governor and Legislature.

Alternative SED-5 is similar to SED-4 in achieving greater protection of human health and the environment. However, this alternative is substantially more expensive than Alternative SED-4 (from approximately $25,000,000 to $33,000,000 or about 65% more expensive using similar sediment treatment) and also presents potentially greater risk to human health, because of the need to work behind barriers engineered to keep out the waters of Lake Superior and because the project duration is estimated to be at least twice as long. In addition, if SED-5 were implemented the use of Kreher Park by the public would be precluded for almost four years which is approximately two years longer than with other alternatives..

If both Alternative SED-4 and soil Alternative S-3B are selected, as much as 350,000 cubic yards of sediment and soil or more may require disposal. Given that outcome, it may be cost effective to site a private NR500 in Ashland on property owned or purchased by NSPW.

Based on this evaluation, Alternative SED-4 would provide the most long-term benefit at the least cost and with the fewest short-term technical implementation issues.

9.0 Integrated Remedial Alternatives

9.1 Introduction

Contamination at the Site includes soil and shallow groundwater contamination in the vicinity of the former MGP and at Kreher Park, groundwater contamination in an underlying confined aquifer, and offshore sediment contamination in the inlet area adjacent to Kreher Park. The FS includes remedial alternatives for contaminated media (soil, groundwater, and sediment). Potential remedial alternatives for soil were screened in the ASTM, and those retained for further evaluation were analyzed in the CAATM. Sections 6.0, 7.0, and 8.0 include a summary of the technical memoranda for soil, groundwater and sediment, respectively. In the two previous technical memoranda, the ASTM and the CAATM, a number of potential remedial alternatives for the various Site media were evaluated. Both of these Technical Memoranda were critically reviewed and, in several instances, modified by USEPA and WDNR. The evaluations presented in these two previous memoranda were critically reviewed and modified by the EPA and WDNR and indicated some alternatives were either technically infeasible or not cost effective and these alternatives were eliminated from further consideration. The remedial alternatives presented in previous sections of this FS are those that survived the evaluation conducted as part of the ASTM and the CAATM. The reader is directed to these two technical memoranda which are attached as Appendix A1 and A2 for details on this evaluation process.

For purposes of investigation, the Site was divided into the following areas of concern as described in the RI report:

1. Filled Ravine
2. Copper Falls Aquifer
3. Kreher Park
4. Offshore Sediments

Because of the limited space in the upland area of the Site and the need to coordinate and potentially share other resources and treatment technologies used in the remediation of groundwater, soil and sediment, this section is provided to illustrate how response actions for these media potentially will be integrated. This will provide a comprehensive "whole site" view of site-wide remedial action. Since many of the detailed designs for the various response actions have to await the Remedial Design stage, this "whole site" view is necessarily conceptual. However, this level of detail should be sufficient to evaluate the feasibility of integrating various response actions and determine whether there are any "fatal flaws" that would preclude them being implemented concurrently or sequentially. In addition, by evaluating how these response actions potentially can be integrated, the "integration effect" of response actions on estimated costs due to either competition for resources or sharing of resources can be determined.

9.2 Site-Wide Integrated Remedies

At the FS stage there remain following screening a large number of potential remedial alternatives depending upon the media and the Site area. Potential remedial responses were reviewed for soil, groundwater, and sediment in Sections 6, 7 and 8, respectively. The filled ravine and Kreher Park include remedial alternatives for both soil and groundwater. Remedial alternatives for the Copper Falls aquifer are limited to groundwater, and remedial alternatives for the offshore sediments are limited to sediment. Table 9-1 includes a summary of potential remedial alternatives for each area of concern consisting of the following:

1) At the upper bluff area, 14 alternatives for remediating the "filled ravine";
2) At the upper bluff area, 7 alternatives for remediating "Copper Falls aquifer";
3) At the lakefront, 12 alternatives for remediating soil and groundwater; and
4) In the lake, 12 alternatives for remediating offshore sediments.

Table 9-1 - Summary of Remedial Alternatives by Areas of Concern

Area of Concern	FS Designation	Description
Filled Ravine	S-1/GW-1	No Action (Section 6.3.1 and 7.3.1)
	S-2	Containment Using Surface Barriers (Section 6.3.2)
	S-3A	Limited Removal and Off-site Disposal (Section 6.3.3)
	S-3B	Unlimited Removal and Off-site Disposal (Section 6.3.3)
	S-4A	Limited Removal and On-site Disposal at Kreher Park (Section 6.3.4)
	S-4B	Unlimited Removal and On-site Disposal at Kreher Park (Section 6.3.4)
	S-5A	Ex-situ Thermal Desorption - On-site treatment (limited removal) (Section 6.3.5)
	S-5B	Ex-situ Incineration - Off-site treatment (limited removal) (Section 6.3.5)
	S-6	On-site Soil Washing (limited removal) (Section 6.3.6)
	GW-2A	Containment Using Vertical Barriers (Section 7.3.2)
	GW-3	Ozone Sparge (Section 7.3.3)
	GW-6	In-site Chemical Oxidation (Section 7.3.6)
	GW-7	Electrical Resistance Heating (Section 7.3.7)
	GW-8	Steam Injection – Contained Recovery of Oily Water (CROW) (Section 7.3.8)
	GW-9A	Groundwater Extraction with EW-4 (Section 7.3.9)
Copper Falls Aquifer	GW-1	No Action (Section 7.3.1)
	GW-3	Ozone Sparge (Section 7.3.3)
	GW-4	Dual Phase / Surfactant Injection (Section 7.3.4)
	GW-6	In-situ Chemical Oxidation (Section 7.3.6)
	GW-7	Electrical Resistance Heating (Section 7.3.7)
	GW-8	Steam Injection via Dynamic Underground Stripping (DUS) (Section 7.3.8)
	GW-9A	Groundwater Extraction with existing system (Section 7.3.9)
	GW-9B	Groundwater Extraction with enhanced groundwater extraction system (Section

Table 9-1 - Summary of Remedial Alternatives by Areas of Concern

Area of Concern	FS Designation	Description
Kreher Park	S-1/GW-1	No Action (Section 6.3.1 and 7.3.1)
	S-2	Containment Using Surface Barriers (Section 6.3.2)
	S-3A	Limited Removal and Off-site Disposal (Section 6.3.3)
	S-3B	Unlimited Removal and Off-site Disposal (Section 6.3.3)
	S-5A	Limited Removal and On-site Disposal at Kreher Park (Section 6.3.4)
	S-5B	Unlimited Removal and On-site Disposal at Kreher Park (Section 6.3.4)
	S-6	Ex-situ Thermal Desorption - On-site treatment (limited removal) (Section 6.3.5)
	GW-2A	Containment using vertical barriers (with hydraulic control of contained area)
	GW-2B	Containment using vertical barriers (with hydraulic control of contained area)
	GW-3	Ozone Sparge (Section 7.3.3)
	GW-5	Containment Using Vertical Barriers and Permeable Reactive Barrier Wall
	GW-6	In-site Chemical Oxidation (Section 7.3.6)
	GW-7	Electrical Resistance Heating (Section 7.3.7)
	GW-8	Steam Injection via Dynamic Underground Stripping (DUS) (Section 7.3.8)
	GW-9B	Groundwater Extraction with enhanced groundwater extraction system (Section
Offshore Sediments	SED-1	No Action (Section 8.3.1)
	SED-2	Confined Disposal facility (CDF) (Section 8.3.2)
	SED-3A	Dredge and Subaqueous Cap with Mechanical Dredge (No treatment prior to off-
	SED-3B	Dredge and Subaqueous Cap with Mechanical Dredge (Thermal Treatment prior to
	SED-3C	Dredge and Subaqueous Cap with Hydraulic Dredge (No treatment prior to off-site
	SED-3D	Dredge and Subaqueous Cap with Hydraulic Dredge (Thermal Treatment prior to
	SED-4A	Dredge all with Mechanical Dredge (No treatment prior to off-site disposal)
	SED-4B	Dredge all with Mechanical Dredge (Thermal Treatment prior to off-site disposal)
	SED-4C	Dredge all with Hydraulic Dredge (No treatment prior to off-site disposal) (Section
	SED-4D	Dredge all with Hydraulic Dredge (Thermal Treatment prior to off-site disposal)
	SED-5A	Dry Excavation (Section 8.3.5)
	SED-5B	Dry Excavation (Thermal Treatment prior to off-site disposal) (Section 8.3.5)

Because it would be impractical to attempt to illustrate every permutation of concurrent or sequential implementation of these various remedial alternatives, through discussions with USEPA and WDNR we have selected nine remedial scenarios that illustrate how a range of representative response actions and remedial technologies and processes could be integrated. These are summarized in Table 9-2.

Remedial responses implemented at each area may require forms and combinations of containment, removal and in-situ treatment. This will result in the generation of solid waste (soil and sediment) and wastewater (from sediment de-watering, excavation de-watering, and long-term groundwater extraction). Significant resources will be committed to the management of these wastes. Cost estimates for the remedial responses evaluated in this report include waste management, but volumes treated or generated will vary among remedial responses. The optimum remedial program for the entire Site may require the utilization of different remedial technologies at each area of concern. The following sections describe suggested remedial scenarios that group these alternatives at each affected area. Elements that will be addressed for each scenario include the following:

1) How different areas of the Site will be used for different activities;
2) Whether there is logic for implementing certain response actions at certain areas of the Site prior to others to prevent cross-contamination;
3) Effectively applying ancillary technologies, i.e. dewatering, wastewater treatment, transportation, and disposal to address more than one medium; and
4) Potential for cost savings from this optimization.

Based on cost estimates presented in this FS, each remedial scenario includes a range of estimated costs for each area of concern. The sum of cost estimates for each area of concern was used to derive a range of costs for remediation at the entire Site. These cost estimates provide useful information to evaluate combinations of potential remedial technologies. However, a more accurate cost estimate of cost savings will not be known until design phase cost estimates are prepared.

Table 9-2 Summary of Integrated Remedial Scenarios

Remedial Scenario	I	II	III	IV	V	VI	VII	VIII	IX
Sediment	Not Applicable	Dredge sediment up to four feet and cap remaining sediment in place **(SED-3).**	Dredge (hydraulic or mechanical) all sediment exceeding 9.5 ppm **(SED-4).**	Dredge (hydraulic or mechanical) all sediment exceeding 9.5 ppm **(SED-4).**	Confined Disposal Facility (CDF) for near shore sediment and material dredged outside of CDF footprint **(SED-2).**	Dry excavation of all sediment exceeding 9.5 ppm **(SED-5).**	Dry excavation of all sediment exceeding 9.5 ppm **(SED-5).**	Dredge (hydraulic or mechanical) all sediment exceeding 9.5 ppm **(SED-4).**	Dry excavation of all sediment exceeding 9.5 ppm **(SED-5).**
Kreher Park	Not Applicable	Surface barriers to prevent direct contact and limit leaching from unsaturated zone **(S-2).**	Limited soil / source removal via off site disposal **(S-3A)**, ex-situ thermal desorption **(S-5A)**, offsite incineration **(S-5B**, or soil washing **(S-6)**, and groundwater remediation via enhanced groundwater extraction for hydraulic control **(GW-9B). -**	Limited soil / source removal via offsite disposal **(S-3A)**, ex-situ thermal desorption **(S-5A)**, offsite incineration **(S-5B)**, or soil washing **(S-6)**, and groundwater remediation via engineered surface and vertical barriers with partial caps and hydraulic control **(GW-2A)**, or with PRB wall **(GW-5).**	CDF at Kreher Park combined with engineered surface and vertical barriers for soil and groundwater contamination at Kreher Park **(GW-2B).**	Limited soil / source removal via offsite disposal **(S-3A)**, ex-situ thermal desorption **(S-5A)**, offsite incineration **(S-5B)**, or soil washing **(S-6)**, and groundwater remediation via engineered surface and vertical barriers with hydraulic control via groundwater extraction using, partial caps for the park **(GW-2A)**, a cap for entire park **(GW-2B)**, or with a PRB wall **(GW-5)** at Kreher Park.	Limited soil / source removal via offsite disposal **(S-3A)**, ex-situ thermal desorption **(S-5A)**, offsite incineration **(S-5B)**, soil washing **(S-6)**, in-situ chemical oxidation **(GW-6),** ERH **(GW-7)**, or steam injection **(GW-8),** and groundwater remediation via ozone sparge **(GW-3)** or enhanced groundwater extraction **(GW-9B)**.	Limited soil / source removal via offsite disposal **(S-3A)**, ex-situ thermal desorption **(S-5A)**, offsite incineration **(S-5B)**, soil washing **(S-6)**, in-situ chemical oxidation **(GW-6),** ERH **(GW-7)**, or steam injection **(GW-8),** and groundwater remediation via engineered surface and vertical barriers with hydraulic control via groundwater extraction and using a cap for the entire park **(GW-2B)**, or with a PRB wall **(GW-5)** at Kreher Park.	Unlimited removal of unsaturated and saturated and off-site disposal **(S-3B).**

Table 9-2 Summary of Integrated Remedial Scenarios

Remedial Scenario	I	II	III	IV	V	VI	VII	VIII	IX
Filled Ravine	Not Applicable	Surface barriers to prevent direct contact and limit leaching from unsaturated zone **(S-2).**	Limited soil / source removal via offsite disposal **(S-3A),** ex-situ thermal desorption **(S-5A)**, offsite incineration **(S-5B)**, or soil washing **(S-6)**, and groundwater extraction using the existing system **(GW-9A).**	Limited soil / source removal via offsite disposal **(S-3A)**, ex-situ thermal desorption **(S-5A)**, offsite incineration **(S-5B)**, or soil washing **(S-6)**, and groundwater remediation via engineered surface and vertical barriers with partial caps and hydraulic control **(GW-2A)**, or with PRB wall **(GW-5)** at Kreher Park.	Soil remediation via limited soil / source removal and onsite disposal **(S-4A)**, and groundwater remediation using existing groundwater extraction system **(GW-9A)**, or soil and groundwater remediation via unlimited removal and onsite disposal **(S-4A).**	Limited soil / source removal via offsite disposal **(S-3A)**, ex-situ thermal desorption **(S-5A)**, offsite incineration **(S-5B)**, or soil washing **(S-6)**, and groundwater remediation via engineered surface and vertical barriers with hydraulic control via groundwater extraction, and partial caps and **(GW-2A)**, or with PRB wall **(GW-5)** at Kreher Park.	Limited soil / source removal via offsite disposal **(S-3A)**, ex-situ thermal desorption **(S-5A)**, offsite incineration **(S-5B)**, soil washing **(S-6)**, in-situ chemical oxidation **(GW-6),** ERH **(GW-7)**, or steam injection **(GW-8),** and groundwater remediation via ozone sparge **(GW-3)** or groundwater extraction from EW-4 with existing system **(GW-9A)**.	Limited soil / source removal via offsite disposal **(S-3A)**, ex-situ thermal desorption **(S-5A)**, offsite incineration **(S-5B)**, soil washing **(S-6)**, in-situ chemical oxidation **(GW-6),** ERH **(GW-7)**, or steam injection **(GW-8),** and groundwater remediation via engineered surface and vertical barriers with hydraulic control via groundwater extraction (at Kreher Park) and, and partial caps and **(GW-2A)**, or with PRB wall **(GW-5)** at Kreher Park.	Unlimited removal of unsaturated and saturated and off-site disposal **(S-3B).**
Copper Falls	Not Applicable	Groundwater / NAPL extraction using the existing system **(GW-9A)**	Groundwater and NAPL remediation via ozone sparge **(GW-3)** or surfactant injection /dual phase recovery **(GW-4)**, and groundwater / NAPL extraction using the existing system **(GW-9A)**, or in-situ	Groundwater remediation via ozone sparge **(GW-3)**, surfactant injection /dual phase recovery **(GW-4)**, and groundwater extraction with the existing system **(GW-9A),** or in-situ chemical oxidation **(GW-6)**, ERH **(GW-7)**,	Groundwater remediation via ozone sparge **(GW-3)**, surfactant injection /dual phase recovery **(GW-4)**, and groundwater extraction with the existing system **(GW-9A),** or in-situ chemical oxidation **(GW-6)**, ERH **(GW-7)**, steam	Groundwater remediation via ozone sparge **(GW-3)**, surfactant injection /dual phase recovery **(GW-4)**, and groundwater extraction with the existing system **(GW-9A),** or in-situ chemical oxidation **(GW-6)**, ERH **(GW-7)**, or	Groundwater remediation via enhanced groundwater extraction **(GW-9B)**.	Groundwater remediation via ozone sparge **(GW-3)**, surfactant injection /dual phase recovery **(GW-4)**, and groundwater extraction with the existing system **(GW-9A),** or in-situ chemical oxidation **(GW-6)**, ERH **(GW-7)**, steam injection **(GW-8),** or enhanced	Groundwater remediation via enhanced groundwater extraction **(GW-9B)**.

Table 9-2 Summary of Integrated Remedial Scenarios

Remedial Scenario	I	II	III	IV	V	VI	VII	VIII	IX
			chemical oxidation **(GW-6),** ERH **(GW-7)**, steam injection **(GW-7),** or enhanced groundwater extraction (**GW-9B**).	steam injection **(GW-7),** or enhanced groundwater extraction (**GW-9B).**	injection (**GW-8),** or enhanced groundwater extraction (**GW-9B).**	steam injection (**GW-8).**		groundwater extraction (**GW-9B).**	

9.2.1 Remedial Scenario I: No Action

As previously discussed the National Contingency Plan (NCP) at Title 40 Code of Federal Regulations (40 CFR §300.430(e)(6)) provides that the no-action alternative should be considered at every site. Implementation of no further action consists of leaving contaminated soil, groundwater and sediment in place; no engineering, maintenance, or monitoring will be required. This combined "no action" remedial scenario is included here only as a baseline to which other remedial scenarios can be compared.

9.2.2 Remedial Scenario II:

This integrated remedial scenario is composed of the following:

- **Sediments:** Alternative SED-3 – Mechanically dredge top four feet of offshore sediments and install subaqueous cap. After dredging is completed, place six inches of clean sediment on dredged areas. Transport decontaminated sediment off site for landfill disposal (or beneficial re-use). Dispose of or burn wood debris separately, and discharge treated wastewater from sediment de-watering; to lake.
- **Kreher Park:** Alternatives S-2 - Containment using surface barriers to prevent infiltration and direct contact with subsurface contamination. Will include surface barriers at former coal tar dump and seep area, at the solid waste disposal area, and the well TW-11 area.
- **Filled Ravine**: Alternative S-2 - Containment using surface barriers to prevent infiltration and direct contact with subsurface contamination. Will include asphalt pavement over filled ravine area.
- **Copper Falls Aquifer:** Alternative GW-9A Operate existing NAPL recovery system.
- **Conduct O&M and Long Term Monitoring:** Collect groundwater samples to ensure contaminants are not migrating off site with groundwater. Collect sediment and surface water samples to ensure contaminants are not migrating through cap. Complete annual inspections to ensure integrity of surface barriers and subaqueous cap and repair damage as needed. Conduct MNR monitoring of sediments.
- **Institutional Controls:** Implement groundwater use and deed restriction as part of remedial response at upper bluff and Kreher Park where contaminants remain in subsurface. Implement deed restriction for subaqueous cap.

9.2.2.1 Site Utilization and Staging

Kreher Park will be used as a staging area for sediment removal activities, which will include temporary storage of dredged sediment, sediment de-watering, waste water treatment, and loading sediment for off-site disposal. Additionally, Kreher Park will be used for the storage of material used to construct the subaqueous cap prior to placement.

Because Kreher Park will be required for staging sediment removal, surface barriers will likely be installed after sediment remediation is complete.[27] New asphalt pavement will be installed over the gravel covered marina parking lot as a surface barrier to prevent infiltration and direct contact with subsurface contamination at the solid waste disposal area. Clay caps will be placed over the former seep and coal tar dump area and the TW-11 area to prevent infiltration and direct contact with subsurface contamination in these areas. In the event that the WWTP is demolished, a clay cap or asphalt pavement will also be placed over this area.

Implementation at the upper bluff would require minimal site disturbance. For the filled ravine, asphalt pavement will be installed on the NSPW property. New asphalt pavement will be placed over the gravel covered storage yard on the north side of St. Claire Street, and existing paved areas south of St. Claire Street will be replaced with new asphalt pavement. The existing groundwater extraction system has been in operation since 2001; continued operation of this system can be implemented immediately. Access will be needed to perform operation, maintenance, and monitoring.

9.2.2.2 Integration of Remedial Processes

Under Remedial Scenario II, contaminants onshore will remain in place beneath surface barriers, and a subaqueous cap will be used to contain offshore contaminated sediments. Deed restrictions and groundwater use restriction will be needed for contained areas as part of the implementation of these remedial responses.

9.2.2.3 Estimated Cost of Integrated Remedy

Estimated costs to implement Remedial Scenario II are summarized below.

Table 9-3 Cost Summary for Remedial Scenario II

Area of Concern	Remedial Response	Capital Costs	OM & M	Total
Offshore Sediment	**SED-3** - Dredge and Cap	$ 33,785,000	$ 715,000	$34,500,000,
Kreher Park	**S-2** - Engineered Surface Barriers	$1,734,000	$22,000	$1,756, 000
Filled Ravine	**S-2** - Engineered Surface Barriers	$164,000	--	$164,000
Copper Falls Aquifer	**GW-9A** - Existing Groundwater Extraction System	$0	$2,220,000	$2,220,000
	Total Estimated Cost	$35.68 M	$2.96 M	$38.64 M

Capital costs include engineering and construction oversight.
Operation, maintenance, and monitoring (OM & M) costs are calculated using a 7-percent discount rate.
All costs include 20-percent contingency rounded to the nearest $1000.

[27] The final decision-making for sequencing remedial action will be determined during final design.

Capital costs for offshore sediment, Kreher Park, and the filled ravine remediation exceed long-term operation, maintenance, and monitoring because these remedial responses each include on-site containment. However, capital costs for soil and groundwater exceed OM & M costs because the groundwater extraction system for the Copper Falls aquifer will be operated for an extended period of time. The above cost estimate assumes that the existing groundwater extraction system will operate for 30 years.

The total estimated cost for Remedial Scenario II is approximately $38.64 million and includes $35.68 million for capital costs, and $2.96 million for OM & M. Of this total, approximately 9-percent is for wastewater treatment, and 5-percent is for solid media treatment, transportation, and disposal. During remedial design, integration of these operations will be more finely evaluated to determine cost-effective management of these waste streams. This same waste stream evaluation will be applied during the design phase for any selected scenario.

9.2.3 Remedial Scenario III

- **Sediments:** Alternative SED-4 - Remove wood debris from offshore sediments and mechanically dredge offshore sediments. After dredging is completed, place six inches of clean sediment on dredged areas. De-water stabilize and thermally treat sediments at Kreher Park area and treat wastewater; discharge treated wastewater to lake. Transport decontaminated sediment off site for landfill disposal or beneficial re-use. Dispose or burn wood debris separately.
- **Kreher Park**: Alternatives S-3A - Limited removal and off-site disposal, or beneficial reuse as backfill following ex-situ thermal treatment,(S-5A), offsite incineration (S-5B), or ex-situ soil washing (S-6), and enhanced groundwater extraction (Alternative GW-9B). Shallow groundwater within the contained area would be treated on-site prior to discharge to the lake.
- **Filled Ravine**: Alternatives S-3A - Limited removal and off-site disposal, or beneficial reuse as backfill following ex-situ thermal treatment, (S-5A), offsite incineration, (S-5B or soil washing (S-6). Site restoration would include surface barriers to restrict groundwater recharge. Shallow groundwater would be extracted from existing well EW-4 located at the mouth of the filled ravine to limit discharge to the contained area at Kreher Park.
- **Copper Falls Aquifer**: Alternatives GW-3 - In-situ treatment via ozone sparge, surfactant injection and dual phase recovery (GW-4), with continued operation of existing groundwater extraction system (GW-9A), or in-situ chemical oxidation (GW-6), ERH, (GW-7), steam injection (GW-8), or enhanced groundwater extraction.
- **Conduct O&M and Long Term Monitoring:** Collect groundwater samples to ensure contaminants are not migrating off site with groundwater. Complete annual inspections to ensure integrity of surface barriers and repair damage as needed. Conduct MNR monitoring of sediments.
- **Institutional Controls:** Implement deed restriction where contaminants remain in subsurface following remedial response at upper bluff and Kreher Park. Implement deed restriction for subaqueous cap. Obtain groundwater use restrictions for shallow groundwater and Copper Falls aquifer as condition of closure.

9.2.3.1 Site Utilization and Staging

Kreher Park will be used as a staging area for sediment removal activities, which will include temporary storage of wood waste, dredged sediment, sediment de-watering and thermal treatment, wastewater treatment, and loading sediment for off-site disposal.

Potential remedial alternatives at Kreher Park include limited removal of contaminated soil from source areas (former coal tar dump and seep areas) and enhanced groundwater extraction to remediate contaminated groundwater. To prevent interference with sediment dredging, limited removal could be completed before or after dredging is complete. Regardless, site restoration should be completed last. Site restoration will include clay caps placed over the former seep and coal tar dump areas and the TW-11 area to prevent infiltration and direct contact with subsurface contamination in these areas. New asphalt pavement will also be placed over the existing gravel-covered marina parking lot as a surface barrier to prevent infiltration and direct contact with subsurface contamination in this area. In the event that the WWTP is demolished, a clay cap or asphalt pavement could also be placed over this area.

Limited removal of contaminated soil from the filled ravine at the upper bluff area could be completed before, during, or after sediment dredging. Excavation will include the demolition of the center section of the U-shaped NSPW service center building, and removal of buried gas holder structures. Site restoration will include the installation of asphalt pavement over the filled ravine. However, site restoration will not be completed until after construction of the selected groundwater remedial response for the underlying Copper Falls aquifer is complete. All potential remedial alternatives for this scenario (ozone sparge, surfactant injection/dual phase recovery, in-situ chemical oxidation, ERH, steam injection, and enhanced groundwater extraction) will require the installation of lateral piping and the installation of sparge wells, injection wells, or extraction wells. Following construction, access will be needed to perform operation, maintenance, and monitoring.

9.2.3.2 Integration of Remedial Processes

At the upper bluff, the existing treatment system could be utilized to treat wastewater generated during excavation de-watering activities. Excavation activities can likely be completed within several weeks. Because the excavation will be completed below the water table, excavation de-watering will be required. The rate of water removed from the excavation will exceed the influent treatment rate, but storage tanks can be used for temporary water storage. However, this system will not be adequate to treat wastewater generated from sediment dewatering. Dredged sediment will require de-watering prior to off-site disposal, which will require temporary onsite wastewater treatment. Equipment used for sediment wastewater treatment could also be used to treat groundwater recovered during excavation de-watering activities. Because the WWTP is not currently in use, it may be possible for surface impoundments (i.e., existing clarifiers) and the building to be used for treating wastewater generated from sediment and excavation de-watering. If the WWTP is demolished, demolition should be completed after treatment of all wastewater generated from remedial activities at the lakefront are complete. If containment using hydraulic control is selected, treatment system equipment could be used for the long-term treatment of contaminated groundwater. This groundwater extraction system will include horizontal wells with on-site treatment. Groundwater extraction will be used to create a sink at Kreher Park that will exceed the rate of recharge from infiltration and groundwater discharge to this fill aquifer. Although the hydraulic gradient at Kreher Park is relatively flat, shallow groundwater at Kreher Park is in hydraulic connection with the lake, and the wood waste is permeable. Because this remedial scenario does not include vertical barriers, pumping rates between 30 to 50 gallons per minute will likely be needed to create the sink that will prevent the off-site migration of contaminants. The design for groundwater extraction at Kreher Park in the absence of vertical barriers may require groundwater modeling or an aquifer performance test during the design phase to evaluate the appropriate pumping rate.

If contaminated sediment is transported off site for landfill disposal then contaminated soil removed from excavations at the upper bluff and at Kreher Park should also be transported off site for landfill disposal. This may require the use of existing NR 500 permitted landfill facilities, or siting and construction of a local landfill per ch. NR 500 requirements for all solid waste generated during remedial activities at the Site. Thermal desorption or incineration of sediment and ex-situ soil washing may be needed to pre-treat contaminated media prior to off-site disposal. Contaminated soil removed during limited excavations could also be treated on site. The on-site treatment of contaminated soil would reduce the volume of material transported off site for disposal if used as backfill for excavated areas.

9.2.3.3 Estimated Cost of Integrated Remedy

Estimated costs to implement Remedial Scenario III are summarized below.

Table 9-4 Cost Summary for Remedial Scenario III

Area of Concern	Remedial Response	Capital Costs	OM & M	Total
Offshore Sediment	**SED-4** - Dredge all	$ 48,185,000	$ 715,000	$ 48,900,000
Kreher Park	**S-3A** - Limited removal/offsite disposal or	$1,509,000	$0	$1,509,000
	S-5A - Limited removal/onsite ex-situ thermal desorption or	$2,158,000	$0	$2,158,000
	S-5B - Limited removal/offsite incineration or	$3,777,000	$0	$3,777,000
	S-6 - Limited removal/ex-situ soil washing	$2,653,000	$0	$2,653,000
	AND			
	GW-9B – Enhanced groundwater extraction.[1]	$762,000	$17,392,000	$18,154,000
Filled Ravine	**S-3A** - Limited removal/offsite	$3,415, 000	$0	$3,415, 000

Table 9-4 Cost Summary for Remedial Scenario III

Area of Concern	Remedial Response	Capital Costs	OM & M	Total
	disposal or			
	S-5A - Limited removal/onsite ex-situ thermal desorption or	$4,706,000	$0	$4,706,000
	S-5B - Limited removal/offsite incineration or	$8,103,000	$0	$8,103,000
	S-6 - Limited removal/ex-situ soil washing	$5,961,000	$0	$5,961,000
	AND			
	GW-9A – Existing groundwater extraction system	Costs included with GW-9B alternative for Kreher Park		
Copper Falls Aquifer	**GW-3** – Ozone sparge or	$1,182,000	$695,000	$1,877,000
	GW-4 – Surfactant injection and dual phase recovery and	$744,000	$682,000	$1,426,000
	GW-9A – Existing groundwater extraction system	Costs are included with alternatives GW-3 and GW-4 above.		
	OR			
	GW-6 – In-situ Chemical Oxidation or	$3,128,000	$2,596,000	$5,724,000
	GW-7 – Electrical Resistance Heating or	$6,880,000	$123,000	$7,003,000
	GW-8 – Steam Injection or	$7,188,000	$123,000	$7,311,000
	GW-9B – Enhanced Groundwater Extraction System	$411,000	$5,979,000	$6,420,000
Total Estimated Cost	Offshore Sediments	$ 48.2 M	$ 0.7 M	$ 48.9 M
	Kreher Park	$2.3 to $3.4 M	$17.4 M	$19.7 to 20.8
	Filled Ravine	$3.4 to $8.1 M	$0	$3.4 to $8.1 M
	Copper Falls Aquifer	$0.4 to $7.2 M	$0.13 to $5.9 M	$1.4 to $7.3 M
	Total Estimated Cost	$54.3 to $66.9 M	$18.2 to $24 M	$73.4 to 85.1 M

Capital costs include engineering and construction oversight.
Operation, maintenance, and monitoring (OM & M) costs are calculated using a 7-percent discount rate.
All costs include 20-percent contingency rounded to the nearest $1,000.
1 – Does not include installation of engineered surface barriers, which are included with remedial alternatives evaluated for soil.

Total estimated costs for Remedial Scenario III are dominated by sediment removal. Enhanced groundwater extraction at Kreher Park (without vertical barriers) leads to the significant OM & M costs. Limited removal of contaminated soil within the filled ravine and off-site disposal or ex-situ thermal desorption are lower cost remedial responses than off-site incineration and soil washing. For the Copper Falls aquifer, in-situ treatment using ozone sparge and surfactant injection are lower than in-situ treatment using chemical oxidation, ERH, steam injection, and enhanced groundwater extraction.

9.2.4 Remedial Scenario IV

- **Sediments:** Alternative SED-4 - Remove wood debris from offshore sediments and mechanically dredge offshore sediments. After dredging is completed, place six inches of clean sediment on dredged areas. Dewater and stabilize sediments at Kreher Park area and treat wastewater; discharge treated wastewater to lake. Transport stabilized sediments off site to NR 500 permitted landfill. Dispose of or burn wood debris separately.
- **Kreher Park:** Alternatives S-3A - Limited removal and off-site disposal, or beneficial reuse as backfill following ex-situ thermal treatment, (S-5A), offsite incineration (S-5B), or ex-situ soil washing (S-6), and engineered surface and vertical barriers with groundwater extraction as hydraulic control (Alternative 2A) or a PRB wall (Alternative GW-5). Alternative 2A includes partial caps at Kreher Park to limit groundwater recharge. Shallow groundwater extracted from the contained area for hydraulic control would be treated onsite and discharged to the lake would be treated as it passes through the PRB wall.
- **Filled Ravine:** Alternative S-3A - Limited removal and off-site disposal, or beneficial reuse as backfill following ex-situ thermal treatment, (S-5A), offsite incineration, (S-5B or soil washing (S-6) and engineered surface and with hydraulic control (Alternative 2A) or a PRB wall (Alternative GW-5) at Kreher Park. Shallow groundwater would discharge to Kreher Park for groundwater extraction or treatment via the PRB wall.
- **Copper Falls Aquifer:** Alternatives GW-3 - In-situ treatment via ozone sparge, surfactant, or injection and dual phase recovery (GW-4), and continued operation of the existing groundwater extraction system (GW-2A), or in-situ chemical oxidation (GW-6), in-situ thermal treatment via ERH (GW-7) or steam injection (GW-8), or enhanced groundwater extraction (GW-9B).
- **Conduct O&M and Long Term Monitoring:** Collect groundwater samples to ensure contaminants are not migrating off site or from the contained area with groundwater. Fluid levels within the contained area will also need to be monitored to ensure that groundwater remains at or below the design elevation. Complete annual inspections to ensure integrity of surface barriers and repair damage as needed. Conduct MNR monitoring of sediments.
- **Institutional controls:** Implement groundwater use and deed restriction as part of remedial response at upper bluff and Kreher Park where contaminants remain in subsurface. Groundwater use restrictions for shallow groundwater in contained areas will also be required.

9.2.4.1 Site Utilization and Staging

Kreher Park will be used as a staging area for sediment removal activities, which will include temporary storage of wood waste, dredged sediment, de-watering, storage and stabilization of sediment, wastewater treatment, and loading sediment for off-site disposal.

Potential remedial alternatives at Kreher Park include limited removal of contaminated soil and containment using engineered surface and vertical barriers. To maintain hydraulic control within the contained area, groundwater would either be extracted and treated onsite prior to discharge to the lake. Alternatively, contaminated groundwater from Kreher Park could be funneled through a permeable reactive barrier (PRB) wall for treatment prior to discharge to the lake. Limited removal of contaminated soil within the contained area may not be necessary if either containment alternative is selected, but if soil is excavated, it should be excavated prior to sediment dredging. Vertical barrier walls should also be excavated prior to sediment dredging. Site restoration should be completed last, and will include clay caps placed over the former seep and coal tar dump areas and the TW-11 area to prevent infiltration and direct contact with subsurface contamination in these areas. New asphalt pavement will also be placed over the existing gravel-covered marina parking lot as a surface barrier to prevent infiltration and direct contact with subsurface contamination in this area. In the event that the WWTP is demolished, a clay cap or asphalt pavement could also be placed over this area.

Limited removal of contaminated soil from the filled ravine at the upper bluff area could be completed before, during, or after sediment dredging. Excavation will include the demolition of the center section of the U-shaped NSPW service center building, and removal of buried gas holder structures. Site restoration will include the installation of asphalt pavement over the filled ravine. However, site restoration will not be completed until after construction of the selected groundwater remedial response the underlying Copper Falls aquifer is complete. All potential remedial alternatives for this scenario (ozone sparge, surfactant injection/dual phase recovery, in-situ chemical oxidation, ERH, steam injection, and enhanced groundwater extraction) will require the installation lateral piping and the installation of sparge wells, injection wells, or extraction wells. Following construction, access will be needed to perform operation, maintenance, and monitoring.

9.2.4.2 Integration of Remedial Processes

If contaminated sediment is transported off site for landfill disposal then contaminated soil removed from excavations at the upper bluff and at Kreher Park should also be transported off site for landfill disposal. This may require the use of existing NR 500 permitted landfill facilities, or siting and construction of a local landfill per ch. NR 500 WAC requirements for all solid waste generated during remedial activities at the Site. Thermal desorption or incineration of sediment and ex-situ soil washing may be needed to pre-treat contaminated media prior to off-site disposal. Contaminated soil removed during limited excavations could also be treated on site. The on-site treatment of contaminated soil would reduce the volume of material transported off site for disposal if used as backfill for excavated areas.

At the upper bluff, the existing treatment system could be utilized to treat wastewater generated during excavation de-watering activities. Excavation activities can likely be completed within several weeks. Because the excavation will be completed below the water table, excavation de-watering will be required. The rate of water removed from the excavation will exceed the influent treatment rate, but storage tanks can be used for temporary water storage. However, this system will not be adequate to treat wastewater generated from sediment dewatering. Dredged sediment will require de-watering and stabilization prior to off-site disposal. This will require temporary on-site wastewater treatment. Equipment used for treatment of wastewater resulting from sediment de-watering could also be used to treat groundwater recovered during excavation de-watering activities, and later used for the long-term treatment of groundwater extracted for hydraulic control of the contained area at Kreher Park. Installation of a PRB wall would eliminate the need for long term treatment of wastewater. Because the WWTP is not currently in use, it may be possible to utilize existing clarifiers and the building to treat wastewater generated from sediment and excavation de-watering. If used for wastewater treatment, the WWTP should be demolished after all wastewater generated from remedial activities at the lakefront are complete.

9.2.4.3 Estimated Cost of Integrated Remedy

Estimated costs to implement Remedial Scenario IV are summarized below.

Table 9-5 Cost Summary for Remedial Scenario IV

Area of Concern	Remedial Response	Capital Costs	OM & M	Total
Offshore Sediment	**SED-4** Dredge all	$33,785,000	$715,000	$34,500,000
Kreher Park	**S-3A** - Limited removal/offsite disposal or	$1,509,000	$0	$1,509,000
	S-5A - Limited removal/onsite ex-situ thermal desorption or	$2,158,000	$0	$2,158,000
	S-5B - Limited removal/offsite incineration or	$3,777,000	$0	$3,777,000
	S-6 - Limited removal/ex-situ soil washing	$2,653,000	$0	$2,653,000
	AND			
	GW-2A - Engineered surface and vertical barriers with hydraulic control or [1]	$4,797,000	$2,505,000	$7,302,000
	GW-5 - Engineered surface and vertical barriers with PRB Wall[1]	$5,658,000	$397,000	$6,055,000
Filled	**S-3A** - Limited removal/offsite	$3,415, 000	$0	$3,415, 000

Table 9-5 Cost Summary for Remedial Scenario IV

Area of Concern	Remedial Response	Capital Costs	OM & M	Total
Ravine	disposal or			
	S-5A - Limited removal/onsite ex-situ thermal desorption or	$4,706,000	$0	$4,706,000
	S-5B - Limited removal/offsite incineration or	$8,103,000	$0	$8,103,000
	S-6 - Limited removal/ex-situ soil washing	$5,961,000	$0	$5,961,000
	AND			
	GW-2A - Engineered surface and vertical barriers with hydraulic control (at Kreher Park)[1] or	Capital costs for surface barriers are included with alternatives S-3A, S-5A, S-5B, and S-6 above, and OM&M costs are included with OM&M costs for Kreher Park.		
	GW-5 - Engineered surface and vertical barriers with PRB Wall (at Kreher Park)[1]			
Copper Falls Aquifer	**GW-3** - Ozone sparge or	$1,182,000	$695,000	$1,877,000
	GW-4 - Surfactant injection and dual phase recovery and	$744,000	$682,000	$1,426,000
	GW-9A - Existing groundwater extraction system	Costs are included with alternatives GW-3 and GW-4 above.		
	OR			
	GW-6 - In-situ Chemical Oxidation or	$3,128,000	$2,596,000	$5,724,000
	GW-7 - Electrical Resistance Heating or	$6,880,000	$123,000	$7,003,000
	GW-8 - Steam Injection or	$7,188,000	$123,000	$7,311,000
	GW-9B - Enhanced Groundwater Extraction System	$411,000	$5,979,000	$6,420,000
Total Estimated Cost	Offshore Sediments	$33.8M	0.7M	$34.5M
	Kreher Park	$7.2 to $7.9 M	$0.4 to $2.5 M	$7.6 to $10 M
	Filled Ravine	$3.4 to $8.1 M	$0	$3.4 to $8.1 M
	Copper Falls Aquifer	$0.4 to $7.2 M	$0.13 to $5.9 M	$1.4 to $7.3 M
	Total Estimated Cost	$44.8 to $57 M	$1.3 to $9.1 M	$46.9 to $59.9 M

Capital costs include engineering and construction oversight.
Operation, maintenance, and monitoring (OM & M) costs are calculated using a 7-percent discount rate.
All costs include 20-percent contingency rounded to the nearest $1,000.
1 – Does not include installation of engineered surface barriers, which are included with remedial alternatives evaluated for soil.

As shown above, estimated costs for Remedial Scenario IV are also dominated by sediment removal. At Kreher Park, estimated costs for containment using a PRB wall are lower than containment using groundwater extraction for hydraulic control. For both Kreher Park and the filled ravine, estimated costs for limited removal with off-site disposal or thermal desorption are lower than off-site incineration and soil washing. For the Copper Falls aquifer, in-situ treatment using ozone sparge and surfactant injection are lower than in-situ treatment using chemical oxidation, ERH, steam injection, and enhanced groundwater extraction

9.2.5 Remedial Scenario V

- **Sediments:** Alternative SED-2 - Construct NR 504, WAC conforming CDF over approximately seven acres of lake bed and all of Kreher Park. Dredge remaining offshore sediments above sediment PRG and dispose in CDF. After dredging is completed, place six inches of clean sediment on dredged areas outside of CDF. Dewater sediment, treat wastewater and discharge to lake. Dispose of or burn wood debris separately.
- **Kreher Park:** Alternative GW-2B – Engineered surface and vertical barriers would be used in conjunction with the on-site CDF. Implement hydraulic control around periphery of CDF, which will include groundwater extraction from the contained area for on-site treatment prior to discharge to the lake.
- **Filled Ravine:** Alternatives S-4 - Conduct limited (Alternative S-4A) or unlimited excavation (Alternative S-4B) of contaminated soil in saturated and unsaturated zone at upper bluff, dispose of these soils in CDF.
- **Copper Falls Aquifer:** Alternatives GW-3 - In-situ treatment via ozone sparge, or surfactant injection and dual phase recovery (GW-4), and continued operation of the existing groundwater extraction system (G-9A), or in-situ chemical oxidation (GW-6), in-situ thermal treatment via ERH (GW-7) or steam injection (GW-8), or enhanced groundwater extraction (GW-9B).
- **Conduct O&M and Long Term Monitoring:** Collect groundwater samples to ensure contaminants are not migrating off site with groundwater. Collect sediment and surface water samples to ensure contaminants are not migrating through CDF. Complete annual inspections to ensure integrity of surface barriers and CDF and repair damage as needed. Conduct MNR monitoring of sediments.
- **Institutional controls:** Implement groundwater use and deed restriction as part of remedial response at upper bluff and Kreher Park where contaminants remain in subsurface.

9.2.5.1 Site Utilization and Staging

Kreher Park and approximately seven acres of lake bottom will be used for construction of the CDF. On- and offshore sections of the vertical barrier should be constructed before sediment dredging begins. Following construction of the vertical barrier walls, this area will then be used as a staging area for sediment removal activities, which will include temporary storage of wood waste, dredged sediment, sediment de-watering, and wastewater treatment.

At the upper bluff, excavation will include the demolition of the center section of the U-shaped NSPW service center building, and removal of buried gas holder structures. Limited or unlimited removal of contaminated soil from the filled ravine could be completed before, during, or after sediment dredging, but must be done before the CDF cap is constructed. The filled ravine excavation should be completed before sediment is placed in the CDF if clean fill from the park is salvaged and used for backfill at the upper bluff. Limited removal of contaminated soil at Kreher Park will not be necessary because contaminated soil and groundwater at Kreher Park will be enclosed in the CDF. The construction of the ch. NR 504, WAC cap over the CDF will be completed in the final phase of construction.

Site restoration at the upper bluff will include the installation of asphalt pavement over the filled ravine. However, site restoration will not be completed until after construction of the selected groundwater remedial response the underlying Copper Falls aquifer is complete. All potential remedial alternatives for this scenario (ozone sparge, surfactant injection/dual phase recovery, in-situ chemical oxidation, ERH, steam injection, and enhanced groundwater extraction) will require the installation of lateral piping and sparge wells, injection wells, or extraction wells. Following construction, access will be needed to perform operation, maintenance, and monitoring.

9.2.5.2 Integration of Remedial Processes

The CDF consists of the containment of contamination at Kreher Park and nearby offshore sediment, contaminated soil from the upper bluff area as well as sediment dredged outside the footprint of the CDF. This remedial scenario integrates removal of soil from the filled ravine and removal of offshore sediment with on-site containment at Kreher Park. The CDF will require long-term operation, maintenance, and monitoring. Because infiltration will recharge groundwater within the contained area, groundwater extraction and treatment from the CDF will likely be required.

At the upper bluff, the existing treatment system could be utilized to treat wastewater generated during excavation de-watering activities. Excavation activities can likely be completed within several weeks. Because the excavation will be completed below the water table, excavation de-watering will be required. The rate of water removed from the excavation will exceed the influent treatment rate, but storage tanks can be used the temporary storage of this water. This system will not be adequate for treatment of wastewater generated by sediment dewatering. Dredged sediment will require de-watering after placement in the CDF. This will require temporary on-site wastewater treatment. Because the WWTP is not currently in use, it may be possible to utilize the existing clarifiers and the building to treat wastewater generated from sediment and excavation de-watering. If used for wastewater treatment, the WWTP should be demolished after all wastewater generated from remedial activities at the lakefront are complete.

9.2.5.3 Estimated Cost of Integrated Remedy

Estimated costs to implement Remedial Scenario V are summarized below.

Table 9-6. Cost Summary for Remedial Scenario V

Area of Concern	Remedial Response	Capital Costs	OM & M	Total
Offshore Sediment	**SED-2** – Confined Disposal Facility (CDF)	$36,285,000	$715,000	$37,000,000
Kreher Park	**SED-2 /GW-2B** – CDF combined with engineered surface and vertical barriers with hydraulic control.			
Filled Ravine	**S-4A** – Limited removal and on-site disposal or[1]	$2,250,000	$0	$2,250,000
	S-4B – Unlimited removal and on-site disposal[1]	$2,772,000	$0	$2,772,000
Copper Falls Aquifer	**GW-3** - Ozone sparge or	$1,182,000	$695,000	$1,877,000
	GW-4 - Surfactant injection and dual phase recovery and	$744,000	$682,000	$1,426,000
	AND			
	GW-9A - Existing groundwater extraction system	Costs are included with alternatives GW-3 and GW-4 above.		
	OR			
	GW-6 - In-situ Chemical Oxidation or	$3,128,000	$2,596,000	$5,724,000
	GW-7 - Electrical Resistance Heating or	$6,880,000	$123,000	$7,003,000
	GW-8 - Steam Injection or	$7,188,000	$123,000	$7,311,000
	GW-9B - Enhanced Groundwater Extraction System	$411,000	$5,979,000	$6,420,000
Total Estimated Cost	Offshore Sediments	$36.2M	$0.7M	$37 M
	Kreher Park			
	Filled Ravine	$2.3 to $2.8 M	$0	$2.3 to $2.8 M
	Copper Falls Aquifer	$0.4 to $7.2 M	$0.13 to $5.9 M	$1.5 to $7.3 M
	Total Estimated Cost	$38.9 to $46.2 M	$0.83 to $6.6 M	$40.8 to 47.1 M

Capital costs include engineering and construction oversight.
Operation, maintenance, and monitoring (OM & M) costs are calculated using a 7-percent discount rate.
All costs include 20-percent contingency rounded to the nearest $1,000.
1 – Does not include installation of engineered surface barriers, or OM & M costs which are included with the CDF costs.

As shown above, estimated costs for Remedial Scenario V are dominated by construction of the CDF, which included the use of engineered surface and vertical barriers at Kreher Park. If material removed from the filled ravine is also placed in the CDF, transportation and disposal costs can be significantly reduced, and estimated costs for limited removal are only slightly less than unlimited removal costs. For the Copper Falls aquifer, in-situ treatment using ozone sparge and surfactant injection are lower than in-situ treatment using chemical oxidation, ERH, steam injection, and enhanced groundwater extraction

9.2.6 Remedial Scenario VI

- **Sediments:** Alternative SED-5 - Construct offshore sheetpile or rock breakwater enclosure and dewater impacted areas; remove debris and excavate offshore sediments; dewater and stabilize sediments at Kreher Park area and treat wastewater and discharge to lake. Transport stabilized sediments to NR 500 permitted landfill. Dispose or burn wood debris separately.
- **Kreher Park:** Alternatives S-3A Limited removal and off-site disposal, or beneficial reuse as backfill following ex-situ thermal treatment (S-5A), offsite incineration (S-5B), or ex-situ soil washing (S-6), and engineered surface and vertical barriers with hydraulic control (Alternative 2A or 2B) or a PRB wall (Alternative GW-5). Alternative 2A includes partial caps at Kreher Park, and Alternative 2B includes capping the entire park. Shallow groundwater extracted for hydraulic control for Alternatives 2A and 2B would be treated onsite and discharged to the lake, or for Alternative GW-5 it would be treated as it passes through the PRB wall.
- **Filled Ravine:** Alternative S-3A - Limited removal and off-site disposal, or beneficial reuse as backfill following ex-situ thermal treatment, (S-5A) offsite incineration, (S-5B or soil washing (S-6) and groundwater remediation via engineered surface and vertical barriers with hydraulic control (Alternative 2A) or a PRB wall (Alternative GW-5) at Kreher Park. Shallow groundwater would discharge to Kreher Park for groundwater extraction or pass through the PRB wall at Kreher Park.
- **Copper Falls Aquifer:** Alternatives GW-3 - In-situ treatment via ozone sparge, surfactant injection and dual phase recovery (GW-4), and continued operation of the existing groundwater extraction system (G-9A), or in-situ chemical oxidation (GW-6), in-situ thermal treatment via ERH (GW-7), or steam injection (GW-8).
- **Conduct O&M and Long Term Monitoring:** Collect groundwater samples to ensure contaminants are not migrating off site with groundwater. Complete annual inspections to ensure integrity of surface barriers and repair damage as needed. Conduct MNR monitoring of sediments.
- **Institutional controls:** Implement groundwater use and deed restriction as part of remedial response at upper bluff and Kreher Park where contaminants remain in subsurface.

9.2.6.1 Site Utilization and Staging

At the lakefront sediment removal will require the use of Kreher Park as a staging area. Sediment removal activities, which will include construction of the offshore sheet pile or rock breakwater enclosure, wood waste and sediment handling and de-watering, and wastewater treatment. Potential remedial alternatives at Kreher Park include limited removal of contaminated soil and containment using engineered surface and vertical barriers. Vertical barrier walls should be installed prior to sediment dredging. Limited removal of contaminated soil within the contained area may not be necessary if soil and shallow groundwater at Kreher Park is contained by surface and vertical barriers. If required, limited removal at Kreher Park should be completed either before or after dredging is complete to prevent interference with sediment removal activities.

To maintain hydraulic control within the contained area, groundwater will be extracted and treated on site, or funneled through a passive permeable reactive barrier (PRB) wall constructed for groundwater treatment prior to discharge to the lake. The PRB wall would require installation concurrent with vertical barrier wall construction. If a PRB wall is not used, groundwater extraction would be required following installation of the vertical barrier walls. Site restoration should be completed last, and will include a ch. NR 500, WAC clay cap over the entire park, or partial caps placed over the former seep and coal tar dump areas and the TW-11 area to prevent infiltration and direct contact with subsurface contamination in these areas. New asphalt pavement will also be placed over the existing gravel-covered marina parking lot as a surface barrier to prevent infiltration and direct contact with subsurface contamination in this area. In the event that the WWTP is demolished, a clay cap or asphalt pavement could also be placed over this area.

Limited removal of contaminated soil from the filled ravine at the upper bluff area could be completed before, during, or after sediment dredging. Excavation will include the demolition of the center section of the U-shaped NSPW service center building, and removal of buried gas holder structures. Site restoration will include the installation of asphalt pavement over the filled ravine. However, site restoration will not be completed until after construction of the selected groundwater remedial response for the underlying Copper Falls aquifer is complete. All potential remedial alternatives for this scenario (ozone sparge, surfactant injection/dual phase recovery, in-situ chemical oxidation, ERH, steam injection, and enhanced groundwater extraction) will require the installation lateral piping and the installation of sparge wells, injection wells, or extraction wells. Following construction, access will be needed to perform operation, maintenance, and monitoring.

9.2.6.2 Integration of Remedial Processes

If contaminated sediment is transported off site for landfill disposal then contaminated soil removed from limited removal excavations at the upper bluff and at Kreher Park should also be transported off site for landfill disposal. This may require the use of existing NR 500 permitted landfill facilities, or siting and construction of a local landfill for all solid waste generated during remedial activities at the Site. Thermal desorption or off-site incineration of sediment and ex-situ soil washing may be needed to pre-treat contaminated media prior to off-site disposal. Contaminated soil removed during limited excavations could also be treated on site. The on-site treatment of contaminated soil would reduce the volume of material transported off site for disposal if used as backfill for excavated areas.

At the upper bluff, the existing treatment system could be utilized to treat wastewater generated during excavation de-watering activities, which can likely be completed within several weeks. Because the excavation will be completed below the water table, excavation de-watering will be required. The rate of water removed from the excavation will exceed the influent treatment rate, but storage tanks can be used for temporary water storage. However, this system will not be adequate for treatment of wastewater generated from sediment de-watering. Dredged sediment will require de-watering prior to off-site disposal, which will require temporary on-site wastewater treatment. Equipment used for sediment wastewater treatment could also be used to treat groundwater recovered during excavation de-watering activities. Installation of a PRB wall would eliminate the long term treatment of wastewater. Because the WWTP is not currently in use, it may be possible to utilize existing clarifiers and the building to treat wastewater generated from sediment and excavation de-watering. If used for wastewater treatment, the WWTP should be demolished after all wastewater generated from remedial activities at the lakefront are complete.

9.2.6.3 Estimated Cost of Integrated Remedy

Estimated costs to implement Remedial Scenario VI are summarized below.

Table 9-7 Cost Summary for Remedial Scenario VI

Area of Concern	Remedial Response	Capital Costs	OM & M	Total
Offshore Sediment	**SED-5** Dry Excavation	$66,885,000	$715,000	$67,600,000
Kreher Park	**S-3A** - Limited removal/offsite disposal or	$1,509,000	$0	$1,509,000
	S-5A - Limited removal/offsite disposal or	$2,158,000	$0	$2,158,000
	S-5B - Limited removal/offsite incineration or	$3,777,000	$0	$3,777,000
	S-6 - Limited removal/ex-situ soil washing	$2,653,000	$0	$2,653,000
	AND			
	GW-2A - Engineered surface (partial cap) and vertical barriers with hydraulic control [1] or	$4,797,000	$2,505,000	$7,302,000
	GW-2B - Engineered surface (full cap) and vertical barriers with hydraulic control [1] or	$9,348,000	$1,469,000	$10,817,000
	GW-5 - Engineered surface and vertical barriers with PRB Wall [1]	$5,658,000	$397,000	$6,055,000
Filled Ravine	**S-3A** - Limited removal/offsite disposal or	$3,415, 000	$0	$3,415, 000
	S-5A - Limited removal/offsite disposal or	$4,706,000	$0	$4,706,000
	S-5B - Limited removal/offsite incineration or	$8,103,000	$0	$8,103,000
	S-6 - Limited removal/ex-situ soil washing	$5,961,000	$0	$5,961,000

Table 9-7 Cost Summary for Remedial Scenario VI

Area of Concern	Remedial Response	Capital Costs	OM & M	Total
	AND			
	GW-2A - Engineered surface and vertical barriers with hydraulic control (at Kreher Park) or	Capital costs for surface barriers are included with alternatives S-3A, S-5A, S-5B, and S-6 above, and OM&M costs are included with OM&M costs for Kreher Park.		
	GW-5 - Engineered surface and vertical barriers with PRB Wall (at Kreher Park)			
Copper Falls Aquifer	**GW-3** – Ozone sparge or	$1,182,000	$695,000	$1,877,000
	GW-4 – Surfactant injection and dual phase recovery	$744,000	$682,000	$1,426,000
	AND			
	GW-9A – Existing groundwater extraction system	Costs are included with alternatives GW-3 and GW-4 above.		
	OR			
	GW-6 – In-situ Chemical Oxidation or	$3,128,000	$2,596,000	$5,724,000
	GW-7 – Electrical Resistance Heating or	$6,880,000	$123,000	$7,003,000
	GW-8 – Steam Injection	$7,188,000	$123,000	$6,420,000
Total Estimated Cost	Offshore Sediments	$66.9 M	$0.7 M	$67.6 M
	Kreher Park	$7.2 to $12 M	$0.4 to $2.5 M	$7.6 to $13.5 M
	Filled Ravine	$3.4 to $8.1 M	$0	$3.4 to $8.1 M
	Copper Falls Aquifer	$0.7 to $7.2 M	$0.13 to $2.6 M	$1.4 to $7.0 M
	Total Estimated Cost	$78.2 to $94.5 M	$1.2 to $5.8 M	$80 to $96.2 M

Capital costs include engineering and construction oversight.
Operation, maintenance, and monitoring (OM & M) costs are calculated using a 7-percent discount rate.
All costs include 20-percent contingency rounded to the nearest $1,000.
1 – Does not include installation of engineered surface barriers, which are included with remedial alternatives evaluated for soil.

As shown above, estimated costs for Remedial Scenario VI are also dominated by sediment removal. At Kreher Park, the estimated cost for and containment using a PRB wall is lower than containment requiring groundwater extraction for hydraulic control. Although placing a cap over the entire park will reduce infiltration and groundwater extraction and treatment cost, the capital cost for installation of this cap exceeds the cost savings; total costs for containment with partial caps is lower than containment using a cap over the entire Park. For both Kreher Park and the filled ravine, estimated costs for limited removal with off-site disposal or thermal desorption are lower than off-site incineration and soil washing. For the Copper Falls aquifer, in-situ treatment using ozone sparge and surfactant injection are lower than in-situ treatment using chemical oxidation, ERH, and steam injection.

9.2.7 Remedial Scenario VII

- **Sediments:** Alternative SED-5 - Construct offshore sheetpile or rock breakwater enclosure and dewater impacted areas; remove debris and excavate offshore sediments; dewater and stabilize sediments at Kreher Park area and treat wastewater and discharge to lake. Transport stabilized sediments to NR 500 permitted landfill. Dispose or burn wood debris separately.
- **Kreher Park:** Alternatives S- 3A - Limited removal and off-site disposal, or beneficial reuse as backfill following ex-situ thermal treatment (S-5A), offsite incineration (S-5B), or soil washing (S-6), or in-situ treatment of source area via chemical oxidation (GW-6), ERH (GW-7), or steam injection (GW-8), and groundwater remediation via ozone sparge (GW-3), or enhanced groundwater extraction (GW-9B).
- **Filled Ravine:** Alternatives S-3A Limited removal and off-site disposal , or beneficial reuse as backfill following ex-situ thermal treatment,(S-5A), offsite incineration, (S-5B or soil washing (S-6), or in-situ treatment of source area via chemical oxidation (GW-6), ERH (GW-7), or steam injection (GW-8), and groundwater remediation via ozone sparge (GW-3), or continued groundwater extraction from EW-4 located at the mount of the filled ravine (GW-9A)..
- **Copper Falls Aquifer:** Alternative GW-9B - Enhanced groundwater extraction, to remove NAPL and contaminated groundwater, which would include additional extraction wells and an upgraded on-site treatment system.
- **Conduct O&M and Long Term Monitoring:** Collect groundwater samples to ensure contaminants are not migrating off site with groundwater. Complete annual inspections to ensure integrity of surface barriers and repair damage as needed. Conduct MNR monitoring of sediments.
- **Institutional controls:** Implement groundwater use and deed restriction as part of remedial response at upper bluff and Kreher Park where contaminants remain in subsurface.

9.2.7.1 Site Utilization and Staging

Kreher Park will be used as a staging area for sediment removal activities, which will include construction of the offshore sheet pile or rock breakwater enclosure, wood waste and sediment handling and de-watering, and wastewater treatment. Potential remedial alternatives at Kreher Park include limited removal or in-situ treatment at source areas, and ozone sparge or groundwater extraction for groundwater remediation. To prevent interference with sediment removal activities, limited removal or in-situ treatment activities and groundwater remediation at Kreher Park could be completed either before or after dredging is complete.

Site restoration should be completed last, and will include clay caps placed over the former seep and coal tar dump areas and the TW-11 area to minimize infiltration and direct contact with residual subsurface contamination in these areas. New asphalt pavement will also be placed over the existing gravel-covered marina parking lot as a surface barrier to prevent infiltration and direct contact with subsurface contamination in this area. In the event that the WWTP is demolished, a clay cap or asphalt pavement could also be placed over this area.

At the upper bluff limited removal or in-situ treatment of source areas within the filled ravine could be completed before, during, or after sediment dredging. Implementation of the selected remedial response will include the demolition of the center section of the U-shaped NSPW service center building. Excavation will require the removal of buried gas holder structures, but in-situ treatment remedial responses will be completed in and around these buried structures. Site restoration will include the installation of asphalt pavement over the filled ravine. However, site restoration will not be completed until after construction of the selected groundwater remedial response the filled ravine and underlying Copper Falls aquifer are complete. All potential remedial alternatives for this scenario (ozone sparge, surfactant injection/dual phase recovery, in-situ chemical oxidation, ERH, steam injection, and enhanced groundwater extraction) will require the installation lateral piping and the installation of sparge wells, injection wells, or extraction wells. Following construction, access will be needed to perform operation, maintenance, and monitoring.

9.2.7.2 Integration of Remedial Processes

Sediment dewatering and stabilization will be conducted at Kreher Park. It may be possible for equipment at the dormant WWTP (i.e. existing clarifiers and the facility building) to be used for treatment of wastewater generated from sediment and excavation de-watering. If used for wastewater treatment, the WWTP should be demolished after all wastewater generated from remedial activities at the lakefront are complete.

Sediment wastewater treatment equipment could also be used for treating wastewater generated from excavation de-watering activities, or from in-situ treatment via chemical oxidation, ERH, or steam injection. However, installation of an ozone sparge system for groundwater remediation would eliminate the need for long term treatment of wastewater.

At the upper bluff, the existing treatment system could be utilized to treat wastewater generated during excavation de-watering activities. Excavation activities can likely be completed within several weeks. Because the excavation will be completed below the water table, excavation de-watering will be required. The rate of water removed from the excavation will exceed the influent treatment rate, but storage tanks can be used for temporary water storage. However, in-situ remedial response for shallow soil and groundwater in the filled ravine and the Copper Falls aquifer will require an upgrade to the existing on-site treatment system for the treatment of wastewater generated during remediation.

If contaminated sediment is transported off site for landfill disposal then contaminated soil removed from excavations at the upper bluff and at Kreher Park should also be transported offsite for land fill disposal. This may require the use of existing NR 500 permitted landfill facilities, or siting and construction of a local landfill per ch. NR 500, WAC requirements for all solid waste generated during remedial activities at the Site. Thermal desorption or incineration of sediment and ex-situ soil washing may be needed to pre-treat contaminated media prior to off-site disposal. Contaminated soil removed during limited excavations could also be treated on site. The on-site treatment of contaminated soil would reduce the volume of material transported off site for disposal if used as backfill for excavated areas.

9.2.7.3 Estimated Cost of Integrated Remedy

Estimated costs to implement Remedial Scenario VII are summarized below.

Table 9-8 Cost Summary for Remedial Scenario VII

Area of Concern	Remedial Response	Capital Costs	OM & M	Total
Offshore Sediment	**SED-5** – Dry Excavation	$66,885,000	$715,000	$67,600,000
Kreher Park	**S-3A** - Limited removal/offsite disposal or	$1,509,000	$0	$1,509,000
	S-5A - Limited removal/offsite disposal or	$2,158,000	$0	$2,158,000
	GW-6 – In-situ Chemical Oxidation or	$2,097,000	$94,000	$2,191,000
	GW-7 – Electrical Resistance Heating (ERH) or	$4,572,000	$72,000	$4,644,000
	GW-8 – Steam injection	$2,450,000	$72,000	$2,522,000
	AND			
	GW-3 – Ozone sparge[1] or	$1,564,000	$84,000	$1,648,000
	GW-9B – Enhanced Groundwater Extraction System[1]	$762,000	$17,392,000	$18,154,000
Filled Ravine	**S-3A** - Limited removal/offsite disposal or	$3,415, 000	$0	$3,415, 000
	S-5A - Limited removal/offsite disposal or	$4,706,000	$0	$4,706,000
	GW-6 – In-situ Chemical Oxidation or	$2,067,000	$67,000	$2,134,000
	GW-7 – Electrical Resistance Heating or	$4,422,000	$51,000	$4,473,000
	GW-8 – Steam Injection	$2,633,000	$51,000	$2,684,000
	AND			
	GW-3 – Ozone sparge and	$206,00	$64,000	$270,000
	GW-9A - Existing Groundwater Extraction System	Costs are included with alternatives GW-9B above.		
Copper Falls Aquifer	**GW-9B** – Enhanced Groundwater Extraction System	$411,000	$5,979,000	$6,420,000

Table 9-8 Cost Summary for Remedial Scenario VII

Area of Concern	Remedial Response	Capital Costs	OM & M	Total
Total Estimated Cost	Offshore Sediments	$66.9 M	$0.7	$67.6 M
	Kreher Park	$2.3 to $6.1 M	$0.1 to $17.5 M	$3.2 to $22.8 M
	Filled Ravine	$2.3 to $4.6 M	$0.06 to $0.13 M	$2.4 to $ 4.9 M
	Copper Falls Aquifer	$0.4 M	$7.2 M	$7.6 M
	Total Estimated Cost	$ 71.9 to $ 78	$8 to $25.3	$80.8 to $102.9

Capital costs include engineering and construction oversight.
Operation, maintenance, and monitoring (OM & M) costs are calculated using a 7-percent discount rate.
All costs include 20-percent contingency rounded to the nearest $1,000.
1 – Does not include installation of engineered surface barriers, which are included with remedial alternatives evaluated for soil.

As shown above, estimated costs for Remedial Scenario VII are also dominated by sediment removal. Estimated costs for ozone sparge at Kreher Park are significantly lower than enhanced groundwater extraction. For both Kreher Park and the filled ravine, estimated costs for limited removal with off-site disposal or thermal desorption are lower than in-situ chemical oxidation, ERH, and steam injection. Capital costs for enhanced groundwater extraction for the Copper Falls aquifer are lower than OM & M costs. Although this remedial response will require additional extraction wells and upgrading an existing groundwater extraction system it will be operated for an extended period of time.

9.2.8 Remedial Scenario VIII

- **Sediments:** Alternative SED-4 - Prior to dredging, construct a breakwater (with third party funds) at the northern boundary of the contaminated sediment area. It is assumed this breakwater will be later utilized by the City in the expansion of the marina as proposed in the City's Lakefront Development Plan. Remove wood debris and dredge contaminated offshore sediments. After dredging is completed, place six inches of clean sediment on dredged areas. Dewater and stabilize sediments at Kreher Park area and treat wastewater and discharge to lake. Transport stabilized sediments to ch. NR 500 permitted landfill. Dispose or burn wood debris separately.
- **Kreher Park:** Alternatives S-3A - Limited removal and off-site disposal, or beneficial reuse as backfill following ex-situ thermal treatment,(S-5A), offsite incineration, (S-5B or soil washing (S-6), or in-situ treatment of source area via chemical oxidation (GW-6), ERH (GW-7), or steam injection (GW-8), and groundwater remediation via engineered surface and vertical barriers with hydraulic control (Alternative 2B) or a PRB wall (Alternative GW-5).. Alternative 2B includes capping the entire park. Shallow groundwater extracted for hydraulic control for Alternatives 2B would be treated onsite and discharged to the lake, or for Alternative GW-5 it would be treated as it passes through the PRB wall.
- **Filled Ravine:** Alternatives S-3A Limited removal and off-site disposal, or beneficial reuse as backfill following ex-situ thermal treatment (S-5A), offsite incineration (S-5B),

or soil washing (S-6), or in-situ treatment of source area via chemical oxidation (GW-6), ERH (GW-7), or steam injection (GW-8), and groundwater remediation via engineered surface and vertical barriers with hydraulic control (Alternative 2B) or a PRB wall (Alternative GW-5) at Kreher Park.

- **Copper Falls Aquifer:** Alternatives GW-3 - In-situ treatment via ozone sparge, surfactant injection and dual phase recovery (GW-4), and continued operation of the existing groundwater extraction system (G-9A), or in-situ chemical oxidation (GW-6), in-situ thermal treatment via ERH (GW-7), steam injection (GW-8), or enhanced groundwater extraction (GW-9B).
- **Conduct O&M and Long Term Monitoring:** Collect groundwater samples to ensure contaminants are not migrating off site with groundwater. Complete annual inspections to ensure integrity of surface barriers and repair damage as needed. Conduct MNR monitoring of sediments.
- **Institutional controls:** Implement groundwater use and deed restriction as part of remedial response at upper bluff and Kreher Park where contaminants remain in subsurface.

9.2.8.1 Site Utilization and Staging

Kreher Park will be used as a staging area for construction of the breakwater and sediment removal activities, which will include temporary storage of wood waste, dredged sediment, sediment de-watering, wastewater treatment, and loading sediment for off-site disposal. Additionally, Kreher Park will be used for storage and on-site treatment of sediment prior to landfill disposal if required.

Potential remedial alternatives at Kreher Park include limited removal or in-situ treatment of contaminated soil or source areas, and containment using engineered surface and vertical barriers. To maintain hydraulic control within the contained area, groundwater would either be extracted and treated onsite, or a pass through a permeable reactive barrier (PRB) wall for treatment. Limited removal or in-situ treatment of source areas within the contained area may not be necessary if either containment alternative is selected, but if performed, source area remediation or removal should be completed prior to sediment dredging. Vertical barrier walls should also be installed prior to sediment dredging. Site restoration should be completed last, and will include a ch. NR 500, WAC clay cap over the entire Park, or clay caps placed over the former seep and coal tar dump areas and the TW-11 area to minimize infiltration and direct contact with residual subsurface contamination in these areas. New asphalt pavement will also be placed over the existing gravel-covered marina parking lot as a surface barrier to prevent infiltration and direct contact with subsurface contamination in this area. In the event that the WWTP is demolished, a clay cap or asphalt pavement could also be placed over this area.

At the upper bluff limited removal or in-situ treatment of source areas within the filled ravine could be completed before, during, or after sediment dredging. Implementation of the selected remedial response will include the demolition of the center section of the U-shaped NSPW service center building. Excavation will require the removal of buried gas holder structures, but in-situ treatment remedial responses will be completed in and around these buried structures.

Site restoration will include the installation of asphalt pavement over the filled ravine. However, site restoration will not be completed until after construction of the selected groundwater remedial response at the filled ravine and underlying Copper Falls aquifer are complete. All potential remedial alternatives for this scenario (ozone sparge, surfactant injection/dual phase recovery, in-situ chemical oxidation, ERH, steam injection, and enhanced groundwater extraction) will require the installation lateral piping and the installation of sparge wells, injection wells, or extraction wells. Following construction, access will be needed to perform operation, maintenance, and monitoring.

9.2.8.2 Integration of Remedial Processes

Kreher Park will be used as a staging area for sediment removal activities, which will include construction of breakwater, wood waste and sediment handling and de-watering, and wastewater treatment. Because the WWTP is not currently in use, it may be possible to utilize existing clarifiers and the building to treat wastewater generated from sediment and excavation de-watering. This equipment could also be used for excavation wastewater. If used for wastewater treatment, the WWTP should be demolished after all wastewater generated from remedial activities at the lakefront are complete. Installation of a PRB wall would eliminate the long term treatment wastewater

At the upper bluff, the existing treatment system could be utilized to treat wastewater generated during excavation de-watering activities. Excavation activities can likely be completed within several weeks. Because the excavation will be completed below the water table, excavation de-watering will be required. The rate of water removed from the excavation will exceed the influent treatment rate, but storage tanks can be used the temporary storage of this water. However, in-situ remedial response for shallow soil and groundwater in the filled ravine will require an upgrade to the existing onsite treatment system for the treatment of wastewater generated during remediation.

If contaminated sediment is transported off site for landfill disposal then contaminated soil removed from excavations at the upper bluff and at Kreher Park should also be transported off site for landfill disposal. This may require the use of existing ch. NR 500 permitted landfill facilities, or siting and construction of a local landfill per ch. NR 500, WAC requirements for all solid waste generated during remedial activities at the Site. Thermal desorption, off-site incineration, ex-situ soil washing may be needed to pre-treat contaminated media prior to off-site disposal. Contaminated soil removed during limited excavations could also be treated on-site. The on-site treatment of contaminated soil would reduce the volume of material transported off-site for disposal if used as backfill for excavated areas.

9.2.8.3 Estimated Cost of Integrated Remedy

Estimated costs to implement Remedial Scenario VIII are summarized below.

Table 9-9 Cost Summary for Remedial Scenario VIII

Area of Concern	Remedial Response	Capital Costs	OM & M	Total
Offshore Sediment	**SED-4** Dredge all	$40,985,000	$715,000	$41,700,000*
Kreher Park	**S-3A** - Limited removal/offsite disposal or	$1,509,000	$0	$1,509,000
	S-5A - Limited removal/offsite disposal or	$2,518,000	$0	$2,518,000
	GW-6 – In-situ Chemical Oxidation or	$2,097,000	$72,000	$2,191,000
	GW-7 – Electrical Resistance Heating (ERH) or	$4,572,000	$72,000	$4,644,000
	GW-8 – Steam Injection or	$2,450,000	$72,000	$2,522,000
	AND			
	GW-3 – Ozone sparge or	$1,564,000	$84,000	$1,684,000
	GW-2B - Engineered surface (full cap) and vertical barriers with hydraulic control or	$9,512,000	$1,469,000	$10,981,000
	GW-5 - Engineered surface and vertical barriers with PRB Wall	$5,658,000	$397,000	$6,055,000
Filled Ravine	**S-3A** - Limited removal/offsite disposal or	$3,415,000	$0	$3,415,000
	S-5A - Limited removal/offsite disposal or	$4,706,000	$0	$4,706,000
	GW-6 – In-situ Chemical Oxidation or	$2,067,000	$67,000	$2,134,000
	GW-7 – Electrical Resistance Heating or	$4,422,000	$51,000	$4,473,000
	GW-8 – Steam Injection	$2,633,000	$51,000	$2,684,000
	AND			
	GW-3 – Ozone sparge and	$206,00	$64,000	$270,000
	GW-2A - Engineered surface and vertical barriers with hydraulic control at Kreher Park	Capital costs for surface barriers are included with alternatives S-3A, S-5A, GW-6, GW-7, and GW-8 above, and OM&M costs are included with OM&M costs for Kreher Park.		

Table 9-9 Cost Summary for Remedial Scenario VIII

Area of Concern	Remedial Response	Capital Costs	OM & M	Total
	GW-5 - Engineered surface and vertical barriers with PRB Wall			
Copper Falls Aquifer	**GW-3** – Ozone sparge or	$1,182,000	$695,000	$1,877,000
	GW-4 – Surfactant injection and dual phase recovery	$744,00	$682,000	$1,426,000
	AND			
	GW-9A – Existing groundwater extraction system	Costs are included with alternatives GW-3 and GW-4 above.		
	OR			
	GW-6 – In-situ Chemical Oxidation or	$3,128,000	$2,596,000	$5,724,000
	GW-7 – Electrical Resistance Heating or	$6,880,000	$123,000	$7,003,000
	GW-8 – Steam Injection	$7,188,000	$123,000	$7,311,000
	GW-9B – Enhanced Groundwater Extraction System	$411,000	$5,979,000	$6,420,000
Total Estimated Cost	Offshore Sediments	$40,985,000	$715,000	$41,700,000*
	Kreher Park	$3.1 to $14 M	$0.08 to $1.5 M	$3.2 to $15.6 M
	Filled Ravine	$2.3 to $4.9 M	$0.06 to $0.13 M	$2.4 to $5 M
	Copper Falls Aquifer	$0.4 to $7.2 M	$0.13 to $6 M	$1.4 to $7.3 M
	Total Estimated Cost	$46.8 to $67.08 M	$0.87 to $8.3 M	$48.7 to $69.6 M

Capital costs include engineering and construction oversight.
Operation, maintenance, and monitoring (OM & M) costs are calculated using a 7-percent discount rate.
All costs include 20-percent contingency rounded to the nearest $100.
*Does not include costs for third party construction of breakwater.
1 – Does not include installation of engineered surface barriers, which are included with remedial alternatives evaluated for soil.

As shown above, estimated costs for Remedial Scenario VIII are also dominated by sediment removal. Estimated costs for ozone sparge at Kreher Park are significantly lower than containment using a PRB wall or containment using groundwater extraction for hydraulic control. For both Kreher Park and the filled ravine, estimated costs for limited removal with off-site disposal or thermal desorption are lower than in-situ chemical oxidation, ERH, and steam injection. For the Copper Falls aquifer, in-situ treatment using ozone sparge and surfactant injection are lower than in-situ treatment using chemical oxidation, ERH, steam injection, and enhanced groundwater extraction

9.2.9 Remedial Scenario IX

- **<u>Sediments:</u>** Alternative SED-5 - Construct offshore sheetpile or rock breakwater enclosure and dewater impacted areas; remove debris and excavate offshore sediments; dewater and stabilize sediments at Kreher Park area and treat wastewater and discharge to lake. Transport stabilized sediments to ch. NR 500, WAC permitted landfill. Dispose or burn wood debris separately.
- **<u>Kreher Park:</u>** Alternative S-3B - Remove all fill material including wood waste and underlying impacted media at Kreher Park. Treat/stabilize soil and transport decontaminated soils off site for disposal. Dispose off the wood waste at an offsite facility.
- **<u>Filled Ravine:</u>** Alternative S-3B -. Removal entire fill and impacted soil including gas holders from the ravine and upper bluff, dispose of these soils to NR500 landfill:
- **<u>Copper Falls Aquifer:</u>** Alternative GW-9B - Enhanced groundwater extraction and treatment of NAPL and groundwater from Copper Falls Aquifer; discharge treated groundwater to sanitary sewer (alternative may also include in-situ treatment of NAPL prior to extraction).
- **<u>Conduct O&M and Long Term Monitoring:</u>** Collect groundwater samples to ensure contaminants are not migrating off-site with groundwater. Complete annual inspections to ensure integrity of surface barriers and repair damage as needed. Conduct MNR monitoring of sediments.
- **<u>Institutional controls:</u>** Implement groundwater use and deed restriction as part of remedial response at upper bluff and Kreher Park where contaminants remain in subsurface. Conduct MNR monitoring of sediments.

9.2.9.1 Site Utilization and Staging

Kreher Park will be used as a staging area for sediment removal activities, which will include construction of the offshore sheet pile or rock breakwater enclosure, wood waste and sediment handling and de-watering, and wastewater treatment. To prevent interference with sediment removal activities, unlimited removal at Kreher Park could be completed either before or after dredging is complete.

The sheet pile wall along the shoreline required for the Kreher Park excavation can be installed before dredging begins, but excavation will not be completed until after sediment remediation is complete. All fill material at Kreher Park will be removed and replaced with clean fill to existing grade. Although the sheet pile wall along the shoreline will prevent lake water from filling the excavation, excavation de-watering will still be required due to groundwater seepage. Water seeping into the excavation area will be removed and treated on site. Because material will be removed from below lake level, it may need to be temporarily stockpiled and dried before transportation off site for disposal. Wood waste and other debris may also need to be separated from soil and temporarily stockpiled on site. Unlimited removal will also necessitate the demolition of the WWTP prior to excavation in this area. Backfilling at Kreher Park will follow the progression of the excavation area, and site restoration will be completed after the excavated area is backfilled to existing grade.

Unlimited removal of contaminated soil from the filled ravine at the upper bluff area could be completed before, during, or after sediment dredging and unlimited removal at Kreher Park. This excavation will require the demolition of the center section of the U-shaped NSPW service center building and removal of buried gas holder structures. Utilities located beneath or adjacent to St. Claire Street will be removed to access fill soil beneath the street. Site restoration will include replacing these utilities, the street pavement, and installation of asphalt pavement over the remainder of the filled ravine. However, site restoration will not be completed until after construction lateral piping for the enhanced groundwater extraction. Following construction, access will be needed to perform operation, maintenance, and monitoring.

9.2.9.2 Integration of Remedial Processes

Dry excavation will require the removal of a significant volume of surface water. Treatment will be required for surface water that is in contact with contaminated sediment and for wastewater generated from sediment de-watering. It may be possible to use portions (i.e. existing clarifiers) of the dormant WWTP at Kreher Park for this wastewater. However, additional wastewater treatment equipment will also be needed. This equipment could also be used to treat wastewater generated during excavation dewatering activities and for the enhanced groundwater extraction system for the Copper Falls aquifer.

9.2.9.3 Estimated Cost of Integrated Remedy

Estimated costs to implement Remedial Scenario IX are summarized below.

Table 9-10 Cost Summary for Remedial Scenario IX

Area of Concern	Remedial Response	Capital Costs	OM & M	Total
Offshore Sediment	**SED-5** – Dry excavation	$ 66,885,000	$ 715,000	$ 67,600,000
Kreher Park	**S-3B** - Unlimited removal/offsite disposal	$35,017,000	$0	$35,017,000
Filled Ravine	**S-3B** - Unlimited removal/offsite disposal	$7,911,000	$0	$7,911,000
Copper Falls Aquifer	**GW-9B** – Enhanced Groundwater Extraction System	$411,000	$5,979,000	$6,420,000
	Total Estimated Cost	$110.2 M	$6.7 M	$116.9 M

Capital costs include engineering and construction oversight.
Operation, maintenance, and monitoring (OM & M) costs are calculated using a 7-percent discount rate.
All costs include 20-percent contingency rounded to the nearest $1,000.

Total estimated cost for Remedial Scenario IX is $116.9 M, which includes $110.2 M for capital costs, and $ 6.7 M for OM & M. Capital costs for sediment removal and removal of a fill material from Kreher Park dominate the estimated cost for this scenario. Capital costs for enhanced groundwater extraction for the Copper Falls aquifer are lower than OM & M costs.

Although this remedial response will require additional extraction wells and upgrading an existing groundwater extraction system it will be operated for an extended period of time.

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APPENDICES

APPENDIX A

FEASIBILITY STUDT TECHNICAL MEMORANDUMS

APPENDIX A1

ALTERNATIVE SCREENING TECHNICAL MEMORANDUM

APPENDIX A2

COMPARATIVE ALTERNATIVES ANALYSIS TECHNICAL MEMORANDUM

APPENDIX B

TREATABILITY STUDY REPORTS

APPENDIX B1

SITE DEMONSTRATION REPORT

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CAP FLUX TESTING REPORT

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BENCH SCALE AIR EMMISSION AND MULTIPHASE FLOW REPORT

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MULTIPHASE TESTING REPORT

APPENDIX C

OCTOBER 25, 2007
WORKSHOP SUMMARY REPORT

APPENDIX D

VOLUME AND WATER BUDGETCALCULATIONS USED FOR EVALUATING REMEDIAL ALTERNATIVES

APPENDIX D1

VOLUMES AND AREAL EXTENT OF CONTAMINATED MEDIA

APPENDIX D2

WATER BUDGET CALCULATIONS FOR KREHER PARK

APPENDIX E

ARARS AND TBCS FOR THE ASHLAND/NSP LAKEFRONT SITE

Table E-1 – ARAR Summary
For Potential Soil Remedial Alternatives

ARAR / TBC	Alternative S-2 Containment Using Surface Barriers		Alternative S-3A and 3B Limited and Unlimited Removal and Off-site Disposal		Alternative S-4A and S-4B Limited Removal and On-site Disposal		Alternative S-5A and 5B Limited Removal and Ex-situ Thermal Treatment		Alternative S-6 Limited Removal and Ex-situ Soil Washing	
	Apply	Comply	Apply	Comply	Apply	Comply	Apply	Comply	Apply	Comply
Chemical Specific										
RCRA – Definition of Hazardous Waste 40 CFR 261	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clean Air Act National Primary and Secondary Ambient Air Quality Standards (NAAQS) 40 CFR Part 50	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clean Air Act National Emissions Standards for Hazardous Air Pollutants (NESHAP) 40 CFR Part 61	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Hazardous Substance Spill Law and Soil Cleanup Standards Ch. 292.11, NR 720	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Groundwater Quality –WAC NR140	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Pollutant Discharge Elimination Systems - WAC NR 200	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Air Pollution Control Regulations – WAC NR 400-499	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Soil Cleanup Standards – WAC NR 720	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Guidance for Generic Soil PAH Cleanup Levels (WDNR PUBL-RR-519-97, April 1997)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Lab Certif. – WAC NR 149	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Action Specific										
CERCLA - Procedures for Planning and Implementing Off-site Response Actions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RCRA - Subtitle D Non-hazardous Waste Standards 40 CFR 257	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RCRA - Manifesting, Transport, and Record keeping Requirements 40 CFR 262	Yes	Yes	Yes	Yes	Yes	Yes	No	NA	No	NA
RCRA - Wastewater Treatment System Standards 40 CFR 264	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RCRA - Excavation and Fugitive Dust	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table E-1 – ARAR Summary
For Potential Soil Remedial Alternatives

ARAR / TBC	Alternative S-2 Containment Using Surface Barriers		Alternative S-3A and 3B Limited and Unlimited Removal and Off-site Disposal		Alternative S-4A and S-4B Limited Removal and On-site Disposal		Alternative S-5A and 5B Limited Removal and Ex-situ Thermal Treatment		Alternative S-6 Limited Removal and Ex-situ Soil Washing	
	Apply	Comply	Apply	Comply	Apply	Comply	Apply	Comply	Apply	Comply
Requirements 40 CFR 264										
RCRA - Storage Requirements 40 CFR 264, 265	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Air Pollution Control Regulations NR 400	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Solid Waste Management Regs NR 500	Yes	Yes	Yes	Yes	Yes	Yes	No	NA	No	NA
WI Hazardous Waste Regulations – NR 600	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Invest. & Remed. of Env. Contamination – NR 700	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Guidance for Cover Systems (Cover Systems as Soil Performance Standard Remedies (WDNR PUBL-RR-709, Jan. 2007)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Guidance for Management of Investigation Derived Waste (Interim Guidelines for the Management of Investigation – Derived Waste (WDNR PUBL-RR- 556-93, May 1993)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Groundwater Discharge Requirements (Informational Document for Wisconsin Discharge Permit; Contaminated Groundwater from Remedial Action Operations (WDNR PUBL- RR-583-01, May 2001)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Management of Waste from Remediation of Manufactured Gas Plants (Draft Management of Waste from Remediation of Manufactured Gas Plants (WDNR PUBL – RR – 768, Feb 2007)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OSHA Occupational Safety and Health Standards	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DOT Haz Mat Transport	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI SPCC – NR 216	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table E-1 – ARAR Summary
For Potential Soil Remedial Alternatives

ARAR / TBC	Alternative S-2		Alternative S-3A and 3B		Alternative S-4A and S-4B		Alternative S-5A and 5B		Alternative S-6	
	Containment Using Surface Barriers		Limited and Unlimited Removal and Off-site Disposal		Limited Removal and On-site Disposal		Limited Removal and Ex-situ Thermal Treatment		Limited Removal and Ex-situ Soil Washing	
	Apply	Comply	Apply	Comply	Apply	Comply	Apply	Comply	Apply	Comply
Location Specific										
Landfill Siting and Approval Processes WI Statutes Ch. 289	No	NA	No	NA	Yes	Yes	No	NA	No	NA
Solid Waste Management Regs – NR 500	Yes	Yes	Yes	Yes	Yes	Yes	No	NA	No	NA
To Be Considered										
WI Water Quality Regs – NR 300	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Safe Drinking Water Act	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Great Lakes Water Quality Agreement	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clean Water Act 303(d)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
EPA Contaminated Management Strategy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
EPA Contaminated Management Guidance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Great Lakes Water Quality Initiative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local Permits	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table E-2 – ARAR Summary for Potential Groundwater Remedial Alternatives																
ARAR / TBC	**Alt. GW-2** Containment using Surface and Vertical Barriers		**Alt. GW-3** In-situ Treatment using Ozone Sparge		**Alt. GW-4** In-situ Treatment using Surfactant Injection		**Alt. GW-5** In-situ Treatment using Permeable Reactive Barrier Walls		**Alt. GW-6** In-situ Treatment using Chemical Oxidation		**Alt. GW-7** In-situ Treatment using Electrical Resistance Heating		**Alt. GW-8** In-situ Treatment using Dynamic Underground Stripping/Steam Injection		**Alt. GW-9** Removal using Groundwater Extraction Wells	
	Apply	**Comply**	**Apply**	**Comply**	**Apply**	**Comply**	**Apply**	**Comply**	**Apply**	**Comply**						
Chemical Specific																
RCRA – Definition of Hazardous Waste 40 CFR 261	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clean Air Act National Primary and Secondary Ambient Air Quality Standards (NAAQS) 40 CFR Part 50	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clean Air Act National Emissions Standards for Hazardous Air Pollutants (NESHAP) 40 CFR Part 61	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Hazardous Substance Spill Law and Soil Cleanup Standards – Ch. 292.11, NR 720	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Groundwater Quality –WAC NR140	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Pollutant Discharge Elimination Systems - WAC NR 200	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Air Pollution Control Regulations – WAC NR 400-499	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Soil Cleanup Standards – WAC NR 720	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Soil Cleanup Standards – WAC NR 720	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Guidance for	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table E-2 – ARAR Summary for Potential Groundwater Remedial Alternatives																
ARAR / TBC	**Alt. GW-2** **Containment using Surface and Vertical Barriers**		**Alt. GW-3** **In-situ Treatment using Ozone Sparge**		**Alt. GW-4** **In-situ Treatment using Surfactant Injection**		**Alt. GW-5** **In-situ Treatment using Permeable Reactive Barrier Walls**		**Alt. GW-6** **In-situ Treatment using Chemical Oxidation**		**Alt. GW-7** **In-situ Treatment using Electrical Resistance Heating**		**Alt. GW-8** **In-situ Treatment using Dynamic Underground Stripping/Steam Injection**		**Alt. GW-9** **Removal using Groundwater Extraction Wells**	
	Apply	**Comply**	**Apply**	**Comply**	**Apply**	**Comply**	**Apply**	**Comply**	**Apply**	**Comply**						
Generic Soil PAH Cleanup Levels (WDNR PUBL-RR-519-97, April 1997)																
WI Lab Certif. – WAC NR 149	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Action Specific																
CERCLA - Procedures for Planning and Implementing Off-site Response Actions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RCRA - Subtitle D Non-hazardous Waste Standards 40 CFR 257	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RCRA - Manifesting, Transport, and Record keeping Requirements 40 CFR 262	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RCRA - Wastewater Treatment System Standards 40 CFR 264	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RCRA - Excavation and Fugitive Dust Requirements 40 CFR 264	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RCRA - Storage Requirements 40 CFR 264, 265	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Air Pollution Control Regulations – NR 400	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Solid Waste Management Regs –	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table E-2 – ARAR Summary for Potential Groundwater Remedial Alternatives																
ARAR / TBC	**Alt. GW-2**		**Alt. GW-3**		**Alt. GW-4**		**Alt. GW-5**		**Alt. GW-6**		**Alt. GW-7**		**Alt. GW-8**		**Alt. GW-9**	
	Containment using Surface and Vertical Barriers		**In-situ Treatment using Ozone Sparge**		**In-situ Treatment using Surfactant Injection**		**In-situ Treatment using Permeable Reactive Barrier Walls**		**In-situ Treatment using Chemical Oxidation**		**In-situ Treatment using Electrical Resistance Heating**		**In-situ Treatment using Dynamic Underground Stripping/Steam Injection**		**Removal using Groundwater Extraction Wells**	
	Apply	**Comply**	**Apply**	**Comply**	**Apply**	**Comply**	**Apply**	**Comply**	**Apply**	**Comply**						
NR 500																
WI Hazardous Waste Regulations – NR 600	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI Invest. & Remed. of Env. Contamination – NR 700	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Guidance for Cover Systems (Cover Systems as Soil Performance Standard Remedies; WDNR PUBL-RR-709, Jan. 2007)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Guidance for Management of Investigation Derived Waste (Interim Guidelines for the Management of Investigation – Derived Waste; WDNR PUBL-RR- 556-93, May 1993	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Groundwater Discharge Requirements (Informational Document for Wisconsin Discharge Permit; Contaminated Groundwater from Remedial Action Operations; WDNR PUBL- RR-583-01, May 2001)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Management of Waste from	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table E-2 – ARAR Summary for Potential Groundwater Remedial Alternatives

ARAR / TBC	Alt. GW-2 Containment using Surface and Vertical Barriers		Alt. GW-3 In-situ Treatment using Ozone Sparge		Alt. GW-4 In-situ Treatment using Surfactant Injection		Alt. GW-5 In-situ Treatment using Permeable Reactive Barrier Walls		Alt. GW-6 In-situ Treatment using Chemical Oxidation		Alt. GW-7 In-situ Treatment using Electrical Resistance Heating		Alt. GW-8 In-situ Treatment using Dynamic Underground Stripping/Steam Injection		Alt. GW-9 Removal using Groundwater Extraction Wells	
	Apply	Comply	Apply	Comply	Apply	Comply	Apply	Comply	Apply	Comply						
Remediation of Manufactured Gas Plants (Draft Management of Waste from Remediation of Manufactured Gas Plants; WDNR PUBL – RR – 768, Feb 2007)																
OSHA – Occupational Safety and Health Standards	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DOT Haz Mat Transport	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WI SPCC – NR 216	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location Specific																
Landfill Siting and Approval Process WI Statutes Ch. 289	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Solid Waste Management Regs – NR 500	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
To Be Considered																
WI Water Quality Regs – NR 300	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Safe Drinking Water Act	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Great Lakes Water Quality Agreement	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clean Water Act 303(d)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
EPA Contaminated Management Strategy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
EPA Contaminated Management Guidance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table E-2 – ARAR Summary for Potential Groundwater Remedial Alternatives																
ARAR / TBC	**Alt. GW-2** Containment using Surface and Vertical Barriers		**Alt. GW-3** In-situ Treatment using Ozone Sparge		**Alt. GW-4** In-situ Treatment using Surfactant Injection		**Alt. GW-5** In-situ Treatment using Permeable Reactive Barrier Walls		**Alt. GW-6** In-situ Treatment using Chemical Oxidation		**Alt. GW-7** In-situ Treatment using Electrical Resistance Heating		**Alt. GW-8** In-situ Treatment using Dynamic Underground Stripping/Steam Injection		**Alt. GW-9** Removal using Groundwater Extraction Wells	
	Apply	**Comply**	**Apply**	**Comply**	**Apply**	**Comply**	**Apply**	**Comply**	**Apply**	**Comply**						
Great Lakes Water Quality Initiative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local Permits	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table E-3 – ARAR Summary for Potential Sediment Remedial Alternatives						
ARAR/TBC	**Alt. SED-2**		**Alt. SED-3**		**Alt. SED-4 and SED-5**	
	Dredge, place in CDF		**Dredge, Cap**		**Dredge-All**	
	Apply	**Comply**	**Apply**	**Comply**	**Apply**	**Comply**
Chemical Specific						
Clean Water Act Section 304, Ambient Water Quality Criteria, US EPA 1986	Yes	Yes	Yes	Yes	Yes	Yes
Clean Water Act Section 303, Water Quality Standards, 40 CFR 131	Yes	Yes	Yes	Yes	Yes	Yes
Clean Water Act Section 304, Sediment Quality Criteria, US EPA 1991	No	NA	No	NA	No	NA
RCRA - Definition of Hazardous Waste, 40 CFR 261	No	NA	No	NA	No	NA
Clean Air Act, National Primary and Secondary Ambient Air Quality Standards (NAAQS), 40 CFR Part 50	Yes	Yes	Yes	Yes	Yes	Yes
Clean Air Act, National Emissions Standards for Hazardous Air Pollutants (NESHAP), 40 CFR 61	No	NA	No	NA	No	NA
WDNR Water Quality Standards for Wisconsin Surface Waters, WAC NR 102-105	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Wisconsin Groundwater Quality, WAC NR 140	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Wisconsin State Air Pollutant Control Regulations, WAC NR 400-499	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Wisconsin State Soil Cleanup Standards, WAC NR 720	No	NA	No	NA	No	NA
WDNR Soil Cleanup Levels for PAHs Interim Guidance, WDNR PUBL RR519-97, April 1997	No	NA	No	NA	No	NA
Location Specific						
Rivers and Harbors Act, 33 CFR 320	Yes	Yes	Yes	Yes	Yes	Yes

Table E-3 – ARAR Summary for Potential Sediment Remedial Alternatives						
ARAR/TBC	**Alt. SED-2**		**Alt. SED-3**		**Alt. SED-4 and SED-5**	
	Dredge, place in CDF		**Dredge, Cap**		**Dredge-All**	
	Apply	**Comply**	**Apply**	**Comply**	**Apply**	**Comply**
WDNR Designated Waters Special Natural Resources Interest, WAC NR 1.05(4) and Wisconsin Statutes 30.01(1 am)	No	NA	No	NA	No	NA
WDNR Landfill Siting and Approval Process, Wisconsin Statutes 289	Yes	Yes/permit	Yes	Yes/permit	Yes	Yes/permit
WDNR Permits in Navigable Waters, Wisconsin Statutes 30	Yes	Yes	Yes	Yes	Yes	Yes
Local Permits (building, zoning, other)	TBD	TBD	TBD	TBD	TBD	TBD
Action Specific						
Clean Water Act Section 401, National Pollutant Discharge Elimination System	Yes	Yes/permit	Yes	Yes/permit	Yes	Yes/permit
Clean Water Act Section 301(b), Effluent Standards- Technology Based Discharge Requirements	No	NA	No	NA	No	NA
CERCLA Procedures for Planning and Implementing Off-site Response Actions, 40 CFR 300.440	No	NA	Yes	Yes	Yes	Yes
RCRA- Manifesting, Transport and Recordkeeping Requirements, 40 CFR 262	No	NA	No	NA	No	NA
RCRA- Wastewater Treatment System Standards, 40 CFR 264	No	NA	No	NA	No	NA
RCRA- Storage Requirements, 40 CFR 264 and 265	No	NA	No	NA	No	NA
RCRA- Subtitle D Non-hazardous Waste Standards, 40 CFR 257	Yes	Yes	Yes	Yes	Yes	Yes
RCRA- Excavation and Fugitive Dust Requirements, 40 CFR 264	Yes	Yes	Yes	Yes	Yes	Yes
DOT Rules for Hazardous Materials Transport, 49 CFR 107-171	No	NA	Yes	Yes	Yes	Yes
OSHA Occupational Safety and Health Standards, 29 CFR 1910.120, 1910.132, 1910.134 and 1910.138	Yes	Yes	Yes	Yes	Yes	Yes
Clean Air Act National Primary and Secondary Ambient Air Quality Standards (NAAQS), 40 CFR Part 50	Yes	Yes	Yes	Yes	Yes	Yes

Table E-3 – ARAR Summary for Potential Sediment Remedial Alternatives						
ARAR/TBC	Alt. SED-2		Alt. SED-3		Alt. SED-4 and SED-5	
	Dredge, place in CDF		Dredge, Cap		Dredge-All	
	Apply	Comply	Apply	Comply	Apply	Comply
Clean Air Act National Emissions Standards for Hazardous Air Pollutants (NEHSHAP), 40 CFR 61	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Designated Waters of Special Natural Resources Interest, WAC NR 1.05(4) and Wisconsin Statutes 30.01(1am)	No	NA	No	NA	No	NA
WDNR Plans and Specifications Review of Projects and Operations, WAC NR 108	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Environmental Analysis and Review Procedures, WAC NR 150	No	NA	No	NA	No	NA
WDNR Laboratory Certification and Registration, WAC NR 149	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Wisconsin Pollutant Discharge Elimination System, WAC NR 200	Yes	Yes/permit	Yes	Yes/permit	Yes	Yes/permit
WDNR Water Quality Antidegradation, WAC NR 207	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Water Quality Antidegradation: Waste Load Allocated, Water Quality-Related Effluent Standards and Limitations, WAC NR 212-220	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Lining of Industrial Lagoons and Design of Storage Structures, WAC NR 213	No	NA	No	NA	No	NA
WDNR Wisconsin's General Permit Program for Certain Water Regulatory Permits, WAC NR 322	Yes	Yes/permit	Yes	Yes/permit	Yes	Yes/permit
WDNR Shoreline Protection, WAC NR 328	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Dredging Contract Fees, WAC NR 346	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Sediment Sampling and Analysis, Monitoring Protocol and Disposal Criteria for Dredging Projects, WAC NR 347	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Wisconsin State Air Pollutant Control Regulations, WAC NR 400-499	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Solid Waste Management, WAC NR 500-520	Yes	Yes	Yes	Yes	Yes	Yes

Table E-3 – ARAR Summary for Potential Sediment Remedial Alternatives						
ARAR/TBC	**Alt. SED-2**		**Alt. SED-3**		**Alt. SED-4 and SED-5**	
	Dredge, place in CDF		**Dredge, Cap**		**Dredge-All**	
	Apply	**Comply**	**Apply**	**Comply**	**Apply**	**Comply**
WDNR Hazardous Waste Management, WAC NR 600-685	No	NA	No	NA	No	NA
WDNR Investigation of Remediation of Environmental Contamination, WAC NR 700	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Notification of the Discharge of Hazardous Substances, WAC NR 706	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Public Information and Participation, WAC NR 714	No	NA	No	NA	No	NA
WDNR Standard for Selecting Remedial Actions, WAC NR 722	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Remedial and Interim Action design, Implementation, Operation, Maintenance and Monitoring Requirements, WAC NR 724	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Great Lakes Water Quality Initiative WAC 102 and 106 USEPA Great Lakes Water Quality Initiative, 1995	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Assessing Sediment Quality in Water Bodies Associated with Manufactured Gas Plant Sites, WDNR PUBL-WR-447-96, March 1996	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Guidance for Cover Systems as Soil Performance Standard Remedies, WDNR-PUBL-RR-709, April 2004	No	NA	No	NA	No	NA
WDNR Consensus-Based Sediment Quality Guidelines: Recommendations for Use and Application Interim Guidance, WDNR-PUBL-WT-732, 2003.	Yes	Yes	Yes	Yes	Yes	Yes
WDHFS Health-Based Guidelines for Air Management, Public Participation and Risk Communication During the Excavation of Former Manufactured Gas Plants, 2004	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Sediment Remediation Implementation Guidance Strategic Directions Report, 1995	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Low-Hazard Solid Waste Exemption, Wisconsin Statutes 289.43	Yes	Yes	Yes	Yes	Yes	Yes

Table E-3 – ARAR Summary for Potential Sediment Remedial Alternatives						
ARAR/TBC	**Alt. SED-2**		**Alt. SED-3**		**Alt. SED-4 and SED-5**	
	Dredge, place in CDF		**Dredge, Cap**		**Dredge-All**	
	Apply	**Comply**	**Apply**	**Comply**	**Apply**	**Comply**
WDNR Interim Guidelines for the Management of Investigation-Derived Waste, WDNR-PUBL_RR-556-93, May 1993	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Informational Document for Wisconsin Discharge Permit; Contaminated Groundwater from Remedial Action Operations, WDNR-PUBL-RR-583-01 May 2001	No	NA	No	NA	No	NA
WDNR Draft Management of Wastes from Remediation of Manufactured Gas Plants, WDNR-PUBL-RR-768, February 2007	Yes	Yes	Yes	Yes	Yes	Yes
To Be Considered						
US EPA Contaminated Sediment Management Strategy, EPA-823-R-98-001	Yes	Yes	Yes	Yes	Yes	Yes
US EPA Contaminated Sediment Management Guidance, EPA-540-R-05-012	Yes	Yes	Yes	Yes	Yes	Yes
US Public Health Service, Agency for Toxic Substances and Disease Registry (*no citation)*	Yes	Yes	Yes	Yes	Yes	Yes
Clean Water Act Section 118(c)(7), Great Lakes Critical Program Act of 1990-Assessment of Remediation of Contaminated Sediments (ARCS) Program, 40 CFR 132 Appendix E	Yes	Yes	Yes	Yes	Yes	Yes
US EPA Contaminated Sediment Management Strategy, EPA-823-R-98-001	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Beneficial Reuse Solid Waste Exemption, WAC NR 500.08	No	NA	Yes	Yes	Yes	Yes
Clean Water Act, Section 404, Dredge and Fill Requirements-Inland Testing Manual	Yes	Yes/permit	Yes	Yes/permit	Yes	Yes/permit
WDNR Dredge and Fill Requirements, 1985 and 1990	Yes	Yes/permit	Yes	Yes/permit	Yes	Yes/permit
WDNR Solid Waste Management, Beneficial Reuse Solid Waste Exemption, WAC NR 500.08	No	NA	Yes	Yes	Yes	Yes

Table E-3 – ARAR Summary for Potential Sediment Remedial Alternatives						
ARAR/TBC	Alt. SED-2		Alt. SED-3		Alt. SED-4 and SED-5	
	Dredge, place in CDF		Dredge, Cap		Dredge-All	
	Apply	Comply	Apply	Comply	Apply	Comply
WDNR Assessing Sediment Quality in Water Bodies Associated with Manufactured Gas Plant Sites, WDNR PUBL-WR-447-96, March 1996	Yes	Yes	Yes	Yes	Yes	Yes
WDNR Consensus-Based Sediment Quality Guidelines, Recommendations for Use & Application, Interim Guidance, WDNR PUBL-WT-732, 2003	Yes	Yes	Yes	Yes	Yes	Yes
International Joint Commission (IJC), IJC, 1992	No	NA	No	NA	No	NA

APPENDIX F

PRELIMINARY REMEDIATION COST ESTIMATES

APPENDIX F1

PRELIMNARY REMEDIATION COST ESTIMATES FOR SOIL

APPENDIX F2

PRELIMNARY REMEDIATION COST ESTIMATES FOR GROUNDWATER

APPENDIX F3

PRELIMNARY REMEDIATION COST ESTIMATES FOR SEDIMENT

APPENDIX G

WAVE HEIGHT ANALYSIS

Appendix G - Wave Run-Up Analysis for CDF

A wave run-up analysis has been completed to determine the required height of the CDF wall such that wave overtopping is limited to a minimal amount. The design period for the analysis is a 100-year return period and the methods used provided in the U.S. Army Corps of Engineers Coastal Engineering Manual (CEM) and Automated Coastal Engineering Software (ACES). The analysis requires as input estimates of the 100-year wave height and period, 100-year still water level, and water depth and bottom slope.

The 100-year wave height and period have been determined as part of the Site Sediment Stability Assessment (URS 2007). In summary, a 24 year hourly wind record was used to estimate wave conditions at the Site using a wind-wave transformation that accounts for fetch, water depth wind speed and duration. The wave height and period determined form the transformation were then analyzed to determine wave heights and periods for 1 through 24 year return periods. Then the Generalized Extreme Value Distribution was fit to the return period data to estimate the 100-year event. The 100-year wave height and period were determined using this approach are 1.04 meters and 4 seconds.

The 100-year still-water elevation at the project site was taken from information published by the Federal Emergency Management Agency (FEMA) in Flood Insurance Rate Maps and Flood Insurance Studies for the area. The 100-year still-water elevation was reported as 604.5 feet NGVD.

The bottom slope in the vicinity of the proposed CDF wall was estimated from local bathymetry data collected as part of the SSA and the data is available in the SSA Report (reference). The water depth was estimated to be 6 feet, based on the 100-year still water elevation, local bathymetry and the proposed location of the CDF wall.

Two methodologies were used to estimate the top of wall elevation needed for the proposed seawall. The first methodology utilized a nomograph relating wall height and overtopping rate. The allowable overtopping rate was estimated using guidance provided in the CEM and is dependent on the land surface condition landward of the seawall. For vegetated or bare ground, the allowable overtopping rate was estimated as 0.005 m^3/s cubic meters per second (cms). If a concrete-paved or riprap apron (3-6" stone size at least four feet wide) is placed immediately landward of the seawall, the allowable overtopping rate was estimated to increase to 0.05 m^3/s cms.

For the estimated allowable overtopping rates above, the required top of seawall elevation was calculated using a nomograph solution from the CEM. The minimum top of seawall elevations for the vegetated and apron configurations were calculated as 608.9 and 606.2 feet NGVD, respectively. These elevations correspond to 4.4 feet and 1.7 feet respectively.

Reference

URS. 2007. Sediment Stability Assessment for the Ashland/Northern States Power Lakefront Superfund Site.

APPENDIX H

SUMMARY OF CAPPING PROJECTS

APPENDIX I

SUMMARY COST FOR SITING, CONSTRUCTING, AND OPERATING A LANDFILL IN ASHLAND

APPENDIX I

Off-site Landfill Siting, Permitting, Construction Requirements and Estimated Costs Ashland/NSP Lakefront Site Feasibility Study

The following assumptions were made to develop a conceptual design and cost estimate for an off-site ch. NR 500 permitted landfill. It is assumed that the off-site landfill would be of substantial capacity to support a "remove all" remedy that includes all sediment from the dredge-all remedies (SED-4 and SED-5) as well as all impacted soils from the upper bluff and Kreher Park.

Assumptions

- Landfill is located within five miles of the Site.
- Volume of waste = 300,000 cu yd +/-
- Landfill perimeter berms 3 horizontal to 1 vertical
- Landfill cover slope varies from 5 to 2 percent
- The perimeter berms of the landfills shell will be constructed of sand and plated with cover soil upon completion of the landfill cover.
- Ground water estimated to be 10 ft below existing ground surface (regulations require bottom of cell to be a minimum of 10 ft above groundwater table landfill).
- Waste will be trucked to site and will be of a consistency (pass a paint filter test) that will allow placement with a dozer in the landfill.
- Trucks loaded with waste will initially drive into the landfill to deposit their load.
- One-way traffic will be allowed on the egress/ingress ramps to the landfill.
- Truck ramp slope is 3 percent
- The information provided below presents the tasks and requirements provided by the WDNR landfill regulations associated with landfill siting through post-closure monitoring.

General Landfill Siting Process

All Wisconsin landfills must obtain both state licensing and any applicable local approvals prior to construction. The landfill licensing process is administered by the WDNR. The local approval process is overseen by the Wisconsin Waste Facility Siting Board. The following sections summarize the tasks and requirements provided by WDNR landfill regulations associated with siting through post-closure monitoring. The costs developed assume completion of these tasks and requirements (Table I1).

Initial Site Inspection (Wisconsin Regulations chs. NR 29 and NR 504, WAC)

The WDNR must first perform an initial inspection of the proposed site to determine if the site has the potential to comply with landfill location criteria and performance standards. An initial

site inspection is also required for all non-commercial soil borrow sources designated to be used for the landfill.
A separate written request must be submitted to the WDNR to arrange for each of the inspections and they both must include:

- A cover letter identifying the applicant, proposed type of landfill and, property ownership, location, and present land use;
- A letter from the WDNR's Bureau of Endangered Resources addressing the known presence of critical habitat areas and state or local natural areas within one mile of the proposed landfill;
- A letter from the Wisconsin State Historical Society identifying the presence of any historical, scientific or archaeological areas within the vicinity of the proposed landfill;
- A map depicting existing conditions within one mile of the proposed boundaries of the proposed landfill; and,
- A preliminary identification of all potential conflicts with the location criteria and performance standards.

The soil borrow source written request also includes preliminary identification of all potential adverse effects on wetlands, critical habitat areas or surface waters.

During the inspection, WDNR staff will evaluate if the proposed landfill is within a floodplain, wetlands, a critical habitat area, or an area with historical / archaeological features. The WDNR will also evaluate the setback distances from the anticipated landfill footprint to navigable waters, state and federal highways, public parks, airports and water supply wells.
It is estimated that one month will be required to complete the initial site inspection process.
The WDNR estimates that their review and analysis of the proposed site will be completed two to four weeks after the initial inspection has been performed if no follow up evaluations or studies are necessary.

Initial Site Report (NR 509)

The next step in the landfill licensing process is to submit an Initial Site Report (ISR), which allows for an opinion from the WDNR on whether a proposed property has potential for development as a landfill before a more extensive feasibility report is prepared. The following landfill information must be determined and submitted with the ISR:

- A description of the proposed property and the anticipated limits of filling;
- Proposed landfill life and disposal capacity;
- Industries to be served;
- Anticipated waste types, characteristics and amount of waste to be handled;
- Anticipated cover frequency;
- Mode of operation;
- The anticipated landfill subbase, base and final grades; and,
- A thorough discussion of the land uses which may have an impact on the suitability of the property for waste disposal or on groundwater quality, including a summary of the

available published information concerning the regional geotechnical characteristics of the proposed location.

The WDNR will review the ISR and write an opinion letter on the proposed property's potential for development as a landfill.

It is estimated that the report can be completed in one to two months. The WDNR estimates that their review and analysis of the ISR will take three months (one month to determine if the initial site report is complete and two additional months to determine if the proposed property has potential, limited potential, or little or no potential for development as a landfill).

Local Approval Process

Any applicable permits or approvals required by pre-existing local ordinances to construct or operate a landfill must be obtained during the WDNR technical decision-making process. These approvals vary from one municipality to another, but typically include such items as zoning variances and building permits. If a negotiated agreement cannot be reached between the local governing bodies and the landfill owner regarding the local approvals, arbitration between the parties, performed by the Wisconsin Waste Facility Siting Board, may be necessary.

The local approval process, if started early enough, should not greatly delay landfill construction because it can be performed simultaneously with the more time-intensive WDNR technical decision-making process.

Pre-Feasibility Report (NR 510)

Performing a pre-feasibility investigation and report is not required. However, it is recommended that this step because it allows the WDNR to make an opinion on the site based on geotechnical information prior to performing the larger scope feasibility study investigation.

The following must be performed and submitted in the feasibility report:

- A site-specific geologic and hydrogeologic investigation and reporting; and,
- A field investigation and soil test results for any non-commercial soil borrow source.

The cost estimate is based on the following scope of work, which includes approximately one-third of the soil borings and monitoring well installations that are required for the feasibility report investigation:

Site Investigation

- Five site borings would be advanced to approximately 25 feet below ground surface;
- Three observation wells and two piezometers would be installed;
- Laboratory tests would consist of two hydraulic conductivity test, five Atterberg limit tests, and five grain size / hydrometer tests;
- Slug testing would be performed in each well to determine the in-situ hydraulic conductivity; and,

- Water level measurements would need to be obtained on a monthly basis for six months (prior to submittal of the feasibility report) from all observation wells, piezometers and from all surface water bodies located within 1,000 feet of the proposed limits of filling until the pre-feasibility report is submitted.

<u>Borrow Source</u>

- Four test pits would be excavated at the clay borrow source; and,
- Laboratory tests would consist of one Modified Proctor test for compaction effort and optimal moisture content, one hydraulic conductivity test (for the Proctor test at or above optimal water content), eight Atterberg limit tests, and eight grain size / hydrometer tests.

It is estimated that four months are needed to complete the pre-feasibility investigation and report.

<u>Feasibility Report (NR 512)</u>

The extensive feasibility investigation and report provides all data necessary for the WDNR to determine if the proposed landfill can be developed from a technical standpoint.
The following must be performed and submitted in the feasibility report:

- A comprehensive and detailed site-specific geologic and hydrogeologic investigation and reporting that includes baseline groundwater quality data;
- A field investigation and soil test results for any non-commercial soil borrow source;
- A preliminary engineering design;
- An environmental assessment, including the existing environment, proposed site physical changes, environmental consequences from landfill operation;
- Waste characterization, as well as leachate characterization and generation estimates;
- An analysis and discussion if conditions are favorable or unfavorable for the development of the proposed landfill, including location criteria and performance standards, site geotechnical information, and construction and operation requirements;
- Documentation of the need for the proposed landfill; and,
- An analysis of the alternatives to landfilling.

It is assumed the following scope of work would be performed for the above ground landfill and borrow site field investigation:

<u>Site Investigation</u>

- Eleven site borings would be advanced to approximately 25 feet below ground surface;
- Five observation wells and six piezometers would be installed;
- Laboratory tests would consist of six hydraulic conductivity test, 15 Atterberg limit tests, and 15 grain size / hydrometer tests;
- Slug testing would be performed in each newly installed well to determine the in-situ hydraulic conductivity;

- Water level measurements would need to be obtained on a monthly basis (for a minimum of 6 months prior to submitting the feasibility report) from all observation wells, piezometers, and from all surface water bodies located within 1,000 feet of the proposed limits of filling. After the feasibility report is submitted, quarterly water level measurements would be obtained for at least one additional year; and,
- Four rounds of baseline groundwater monitoring would be performed on all installed observation wells and piezometers (will be submitted with the feasibility report).

Borrow Source

- Ten test pits would be excavated at the clay borrow source; and,
- Laboratory tests would consist of two Modified Proctor tests for compaction effort and optimal moisture content, two hydraulic conductivity tests (one for each Proctor test at or above optimal water content), 20 Atterberg limit tests, and 20 grain size / hydrometer tests.

The proposed preliminary design included in the feasibility report must include preliminary materials balance calculations for the necessary volume of clay, proposed methods for leachate and gas control, proposed operating procedures including the general sequence of filling, a description of the proposed groundwater, leachate, surface water, gas, air, unsaturated zone and other monitoring programs, proposed methods for storm water control, proposed final site use, and preliminary engineering drawings.
It is estimated that 8 to 10 months will be required to complete the feasibility investigation and report.

WDNR Environmental Analysis and Public Hearings (NR 150)

After reviewing the feasibility report, the WDNR hydrogeologist prepares an analysis of any impacts the proposed project would have on the public's health, welfare and the environment and recommends whether or not an Environmental Impact Statement (EIS) should be completed. If an Environmental Impact Statement (EIS) is completed, the WDNR feasibility completeness determination is delayed until the EIS is finished and a public hearing on its completeness is held. Due to the uncertainty of what the WDNR may be required for the EIS, a range of costs are provided on Table 1C for performing the EIS.

A public notice is published and an informational public hearing can be requested or a contested case hearing be held on the technical feasibility of any landfill. If no hearing is requested, the plan review team considers the public comments received before writing the feasibility determination.
The WDNR estimates that the completion of the associated public hearing could take up to a year. The WDNR also estimates that their review and overall completion of the feasibility step may range from six months to more than three years, if an EIS is required.

Plan of Operation Report (chs. NR 514, NR 507)

After the WDNR has approved the feasibility report, a plan of operation report can be completed. There is usually at least one meeting between the applicant and the WDNR to discuss the feasibility conditions of approval prior to the submittal of the plan of operation report. The following must be submitted in the plan of operation report:

- Final engineering design of the landfill;
- Design calculations;
- Details and specifications for the construction;
- Proposed construction documentation;
- Sequencing of filling operations;
- Daily landfill operations;
- Site monitoring during filling;
- Cover design;
- Long-term care and monitoring of the proposed landfill after closure; and
- A detailed estimate of the costs for construction, operation, closure and long-term care of the landfill.

It is estimated that five to six months will be required to complete the plan of operation report. The WDNR estimates that their review of a plan of operation will take three to six months.

Bid Document

After the plan of operation report is approved, bid documents will be developed for the contractors bidding on landfill construction. The bid documents will include:

- Construction specifications;
- Construction drawings;
- Bid forms;
- Contract documents; and,
- All other forms and documents necessary for bidding the landfill construction.

It is estimated that the time to complete the bid documents is three to four months.

Landfill Construction

Landfill construction will commence after all local and WDNR approvals have been obtained. Using the Wisconsin state regulations, a preliminary design was prepared for an approximate 21 acre, 300,000 cubic yards capacity above ground landfill with the following liner system (from bottom to top):

- Four foot thick barrier layer of compacted clay;
- Nominal 60−mil or thicker geomembrane liner;

- One foot thick sand leachate collection layer with leachate collection pipes no greater than 130 feet apart; and
- 12-oz geotextile layer.

Perimeter soil berms will also need to be constructed for the above ground landfill on which the 3 Horizontal to 1 Vertical (3H:1V) side slopes of the landfill can be constructed.
The estimated quantities and costs for constructing the components of the liner system are listed in the attached cost tables. This cost also includes construction oversight and quality assurance testing and construction quality control.
It is estimated that the time to construct the above ground landfill may range between eight and ten months, and will depend on the contractor's ability to haul and place large volumes of material and the weather conditions.

Landfill Liner Construction Completion Report (NR 516)

After construction, a comprehensive report containing a detailed as-built description and documentation of the construction of the landfill must be submitted, including:

- Surveys of various grades;
- Field and laboratory soil and geosynthetics test results;
- Engineering drawings documenting the constructed grades;
- The precise location of all leachate collection storage and removal structures;
- The specifications of materials; and
- Photo documentation.
- After the documentation report and the proofs of financial responsibility have been approved and a final WDNR site inspection is made, the WDNR will issue a license allowing the landfill to accept waste.

It is estimated that the time to complete the landfill construction documentation report to be three to four months. The WDNR estimates that their review of the report will take one month.

Landfill Closure and Post-Closure Monitoring Plan Report

Costs for closure and post-closure monitoring of the landfill are included with the plan of operation report. A separate closure report may be required if remediation for groundwater or surface water contamination or control gas migration is necessary. Costs for preparing a separate closure report are not included.

Landfill Cover Construction

Using the requirements of the WDNR, a preliminary design was created for the following cover system (from bottom to top):

- One foot thick sand grading layer and passive gas extraction system over the waste with passive gas collection piping lines and gas venting wells embedded within the sand grading layer;
- Two foot thick barrier layer of compacted clay;
- Nominal 40−mil or thicker geomembrane liner;
- 2.5 foot thick drainage and rooting zone layer, including a one foot sand drainage layer (hydraulically connected to perimeter drain pipes at the bottom of the cover) and a 1.5 foot thick soil rooting zone; and,
- 0.5 foot thick topsoil layer to support vegetation.

The estimated quantities and costs for constructing the components of the cover system are provided in the attached tables. This cost also includes construction oversight and quality assurance / quality control testing and construction.

It is estimated that the time to complete the cover construction range between four and six months, and will depend on the contractor's ability to haul and place large volumes of material and the weather conditions.

Landfill Cover Construction Completion Report (NR 516)

After cover construction is complete, a comprehensive report containing a detailed as-built description and documentation of the cover construction will be submitted. This report includes:

- Surveys of the final grades of the refuse material and each of the cover soil layers;
- Field and laboratory soil and geosynthetic test results;
- Engineering drawings documenting the grades of the constructed layers;
- Detail drawings and the location of gas extraction structures;
- The rates and types of fertilizer, seed, and mulch applied; and,
- Photo documentation.

It is estimated the time to complete the landfill construction documentation report to range between three to four months.

Post-Closure Monitoring (NR 507)

The plan of operation report includes a plan for post-closure monitoring of the landfill for a period of 40 years. Post-closure monitoring includes:

Inspection and maintenance of cover vegetation, storm water control structures, ground surface settlement or siltation, erosion damage, gas and leachate control features;
Gas, leachate and groundwater monitoring and reporting; and,
Other long-term care needs.

A figure (Figure I-1) depicting the conceptual landfill design is presented below.

Table I-1 Summary of Costs for Siting, Permitting, Construction and Maintenance of an Off-site ch. NR 500 Permitted Landfill

Process	Estimated Cost
Initial Site Inspection	$17,860
Initial Site Report	$27,180
Local Approvals	$16,100
Pre-Feasibility Report	$70,885
Feasibility Report	$165,790
Environmental Assessment*	$250,000
Public Hearings	$20,260
Plan of Operation Report	$286,370
Bid Documents	$87,280
Construction of Landfill/Cover	$10,311,220
Landfill Construction Completion Report	$53,340
Cover Construction Completion Report	$42,620
Load and Transport all Sediment and Soil	$2,463,615
Post Closure Monitoring (40-years)	$1,288,350
Subtotal	$15,100,870
Contingency (20%)	$3,020,174
Estimated Total Cost	$18,121,044

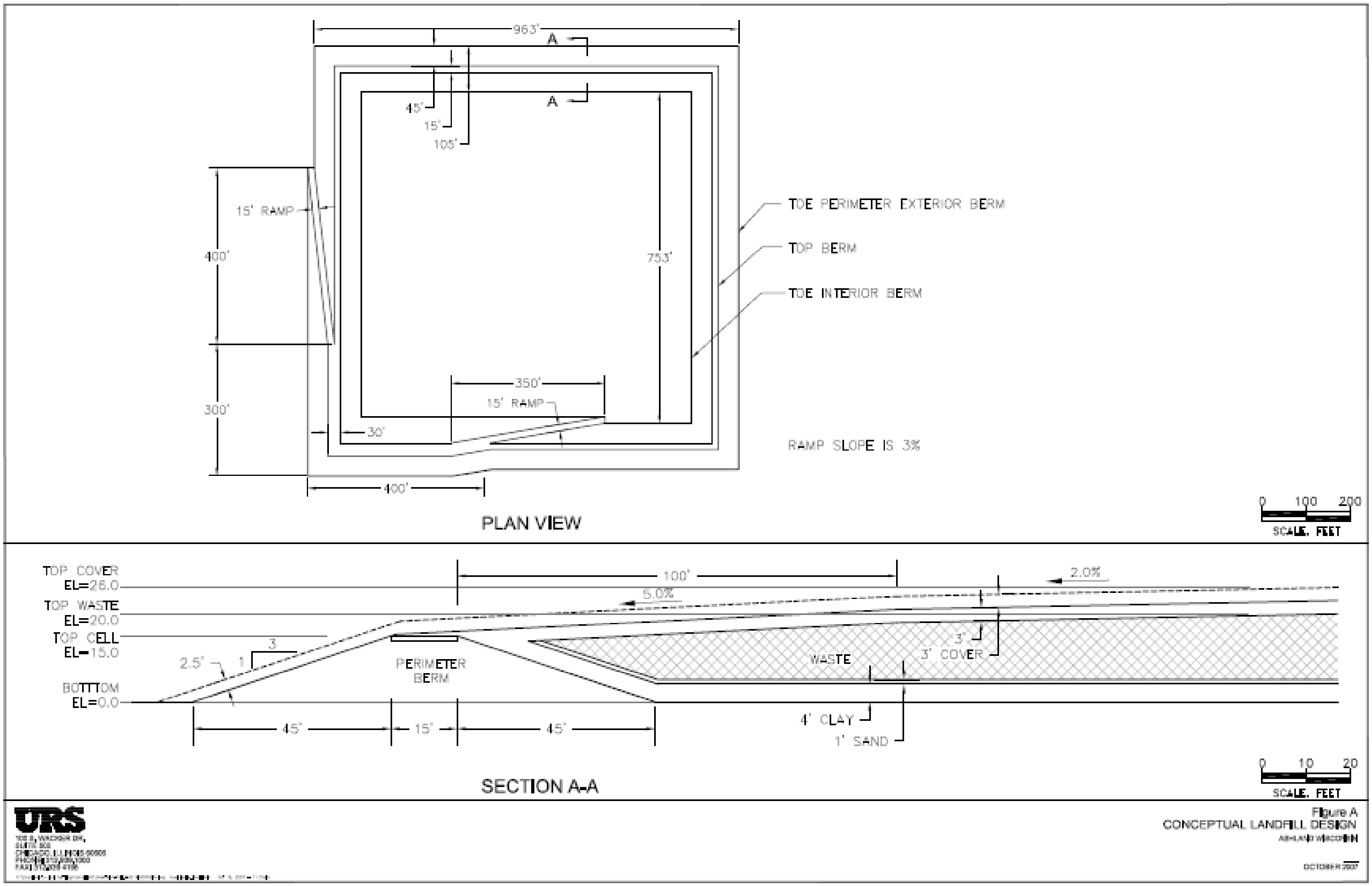

Figure 1-I: Conceptual landfill design.